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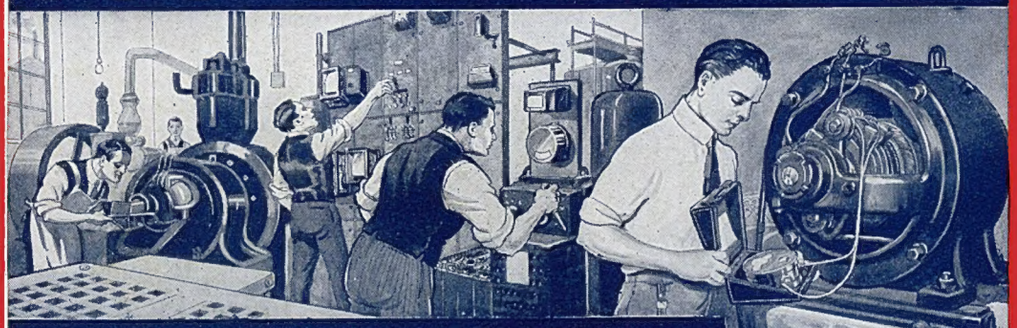

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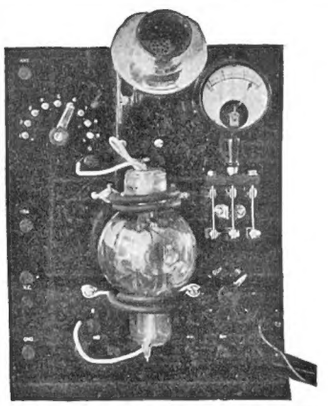

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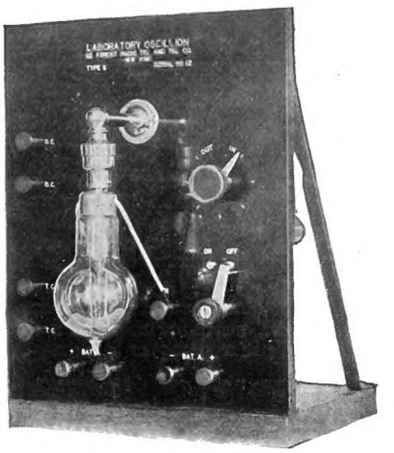

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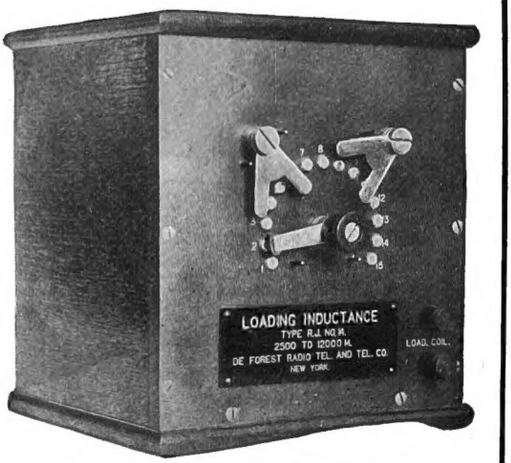

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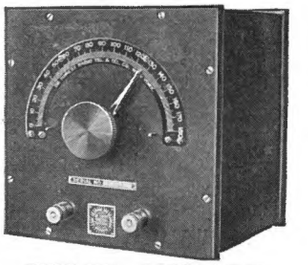

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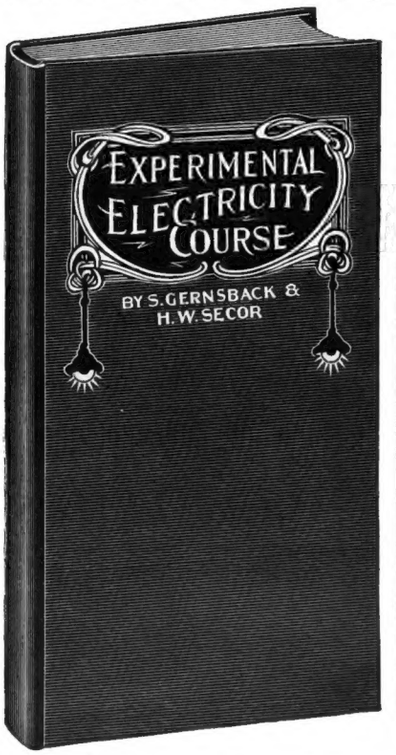

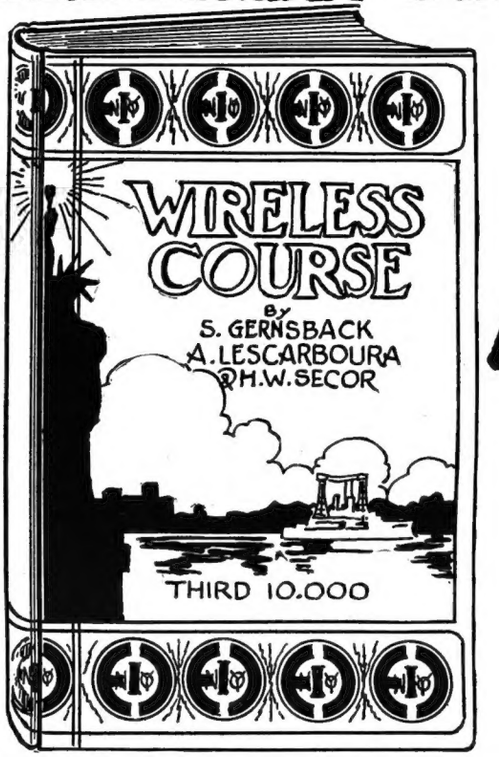

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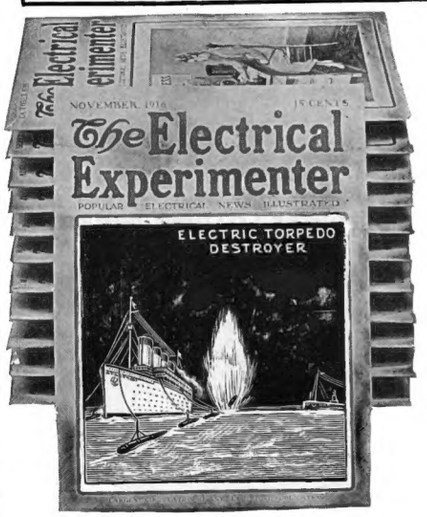

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The Submarine War

THERE is hardly a problem today of greater importance and of a greater complexity than the submarine warfare. It affects not only this nation, but every nation, big and little, over the entire globe.

So complex and so entirely new is this problem that it paralyzes clear thinking of expert and layman alike. Logic runs rampant, even great thinkers and scientists continuously clashing in their widely divergent opinions. There is a chaos of plans, suggestions, inventions and schemes that seem to stupefy everyone concerned in solving the problem. And there seems to be no ray of light in all the darkness so far.

A visitor from Mars, not affected by the war fever bacillus, which now infects the whole world, would surely look in amazement upon the strange spectacle now being enacted upon this planet.

He would marvel first, that during the three years of submarine warfare, no general *plan* to combat the danger had been evolved by the several Allies. Everyone seems to be trying something different from somebody else, but there is no cohesion, no general coöperation that he could perceive.

Our Martian friend, after having looked on a while would probably say: "With the scientific knowledge now at your command, there are only a few ways to successfully combat the submarine evil. Either one will do perfectly, choose the one which is best adapted to your present day technique. Broadly speaking, there are only three practical means of effectively dealing with the submarine. They are:

"1st. Destroy the submarine.

"2nd. Prevent the torpedo from reaching the attacked ship.

"3rd. Blind the submarine so it can not take the ship's bearings."

There are, of course, more means than these three, but they can be left out on account of being impractical. Also each one of the above classes can be subdivided into numerous other classes; thus the suggestion to find a means of preventing the submarine from leaving its harbor comes really under class 2 because the primary purpose of a submarine is to sink ships with a torpedo. Gunfire from the U-boat is a secondary consideration, for with ships becoming armed more and more, the submarine is forced to rely upon its torpedoes.

At the present time our inventors are wasting valuable time trying to invent submarine "detectors." Of what earthly use are these? Suppose we *do* know that a submarine is near our ships? Suppose that we even know its exact position? What will it help us? Our knowledge will certainly not prevent a torpedo from reaching our ship. You can't destroy a submerged U-boat as yet. Even running in a zig-zag line does not always help, for the crafty U-boat commander, if he can but take a few observations, running in a straight line behind the fleeing ship, will average the zig-zag course and if he wants to use two torpedoes, one of these almost certainly will find its mark.

While in some high quarters the opinion prevails that there will never be found a real cure against the submarine evil, we refuse to share such a view. There has never been a weapon in all history which in time did not find its equal or its master. The submarine and its torpedo will prove no exception to this rule. Science in the end will conquer as it always does.

It is more than probable that it will not be a startling new invention that will solve the problem. Rather, we venture the opinion that a combination of well known and tried out methods will do the trick. All indications point that way. Also, we believe that either means 2 or 3 as above enumerated will prove the simpler of the three.

If we would only make up our minds which course to pursue, the solution of the problem would be reached much sooner.

It is foolish and humiliating trying to build ships faster than the U-boats can sink them. If we pursue this course the U-boat will win in the end. If the sun melts your ice too fast you don't go and put out more ice in the sun. You devise means to keep the sun away from the ice, by protecting the latter.

The submarine war is no different. And we will need a lot of ships. Let our inventors devise means to protect them adequately.

H. GERNSBACK.

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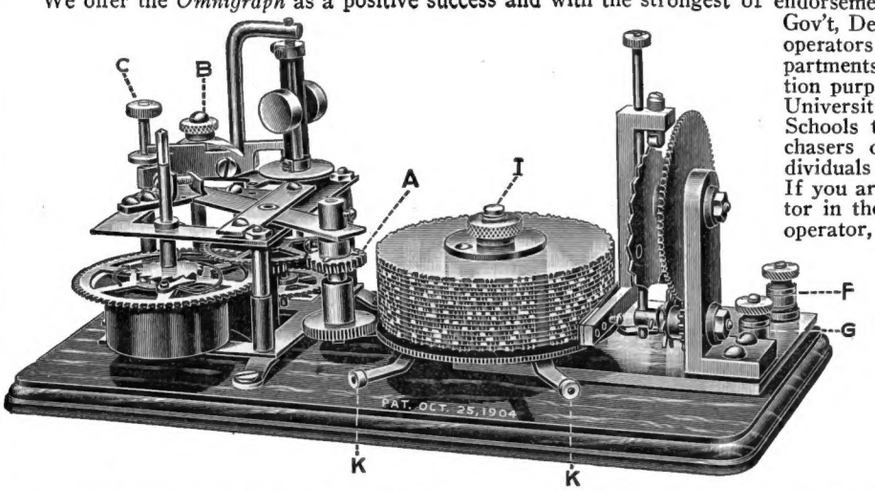

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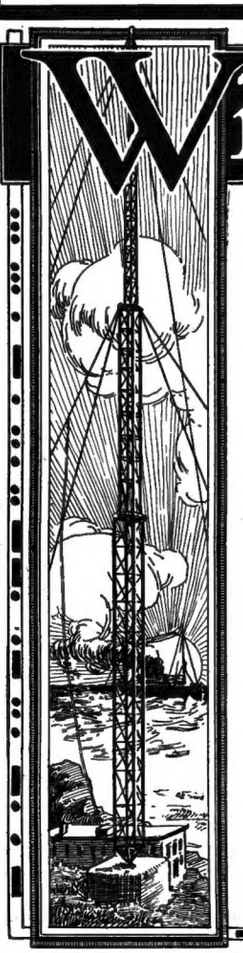

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Vol. V. Whole No. 52 August, 1917 Number 4

Tesla's Views on Electricity and the War

By H. WINFIELD SECOR

Exclusive Interview to THE ELECTRICAL EXPERIMENTER

NIKOLA TESLA, one of the greatest of living electrical engineers and recipient of the seventh "Edison" medal, has evolved several unique and far-reaching ideas which if developed and practically applied should help to partially, if not totally, solve the much discust submarine menace and to provide a means whereby the enemy's powder and shell magazines may be exploded at a distance of several miles.

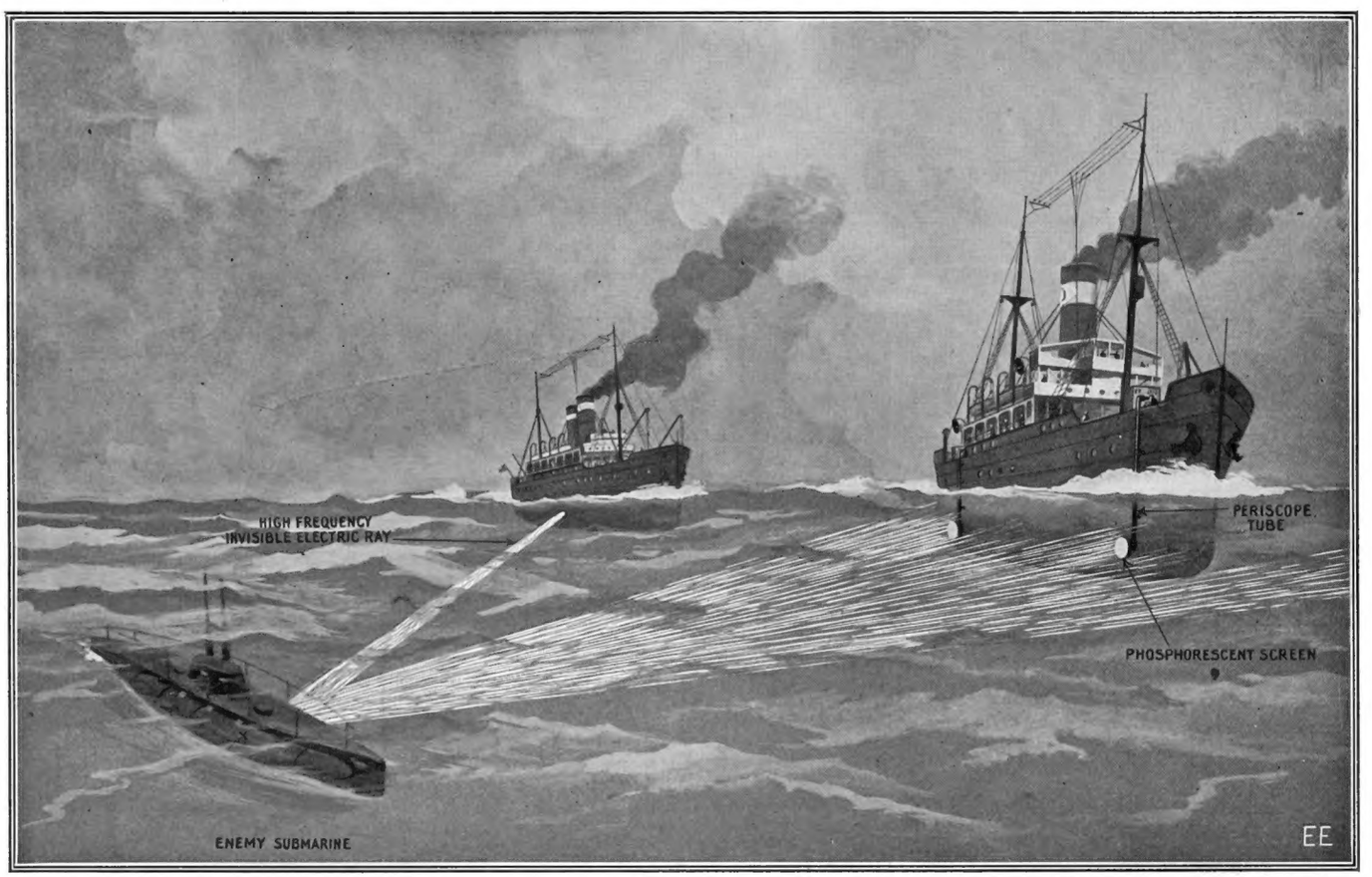
There have been numerous stories bruited about by more or less irresponsible self-styled experts that certain American inventors, including Dr. Tesla, had invented among other things an *electric ray* to destroy or detect a submarine under water at a considerable distance. Mr. Tesla very courteously granted the writer an interview and some of his ideas on electricity's possible rôle in helping to end the great world-war are herein given:

The all-absorbing topic of daily conversation at the present time is of course the "U-boat." Therefore, I made that subject my opening shot.

"Well," said Dr. Tesla, "I have several distinct ideas regarding the subjugation of the submarine. But lest we forget, let us not underestimate the efficiency of the means available for carrying on submarine warfare. We may use microphones to detect the submarine, but on the other hand the submarine commander may employ microphones to locate a ship and even torpedo it by the range thus found, without ever showing his periscope above water.

"Many years ago while serving in the capacity of chief electrician for an electric plant situated on the river Seine, in France, I had occasion to require for certain testing purposes an extremely sensitive galvanometer. In those days the quartz fiber was an unknown quantity—and I, by becoming specially adept, managed to produce an extremely fine cocoon fiber for the galvanometer suspension. Further, the galvanometer proved very sensitive for the location in which it was to be used; so a special cement base was sunk in the ground and by using a lead sub-base suspended on springs all mechanical shock and vibration effects were finally gotten rid of.

"As a matter of actual personal experience," said Dr. Tesla, "it became a fact that the small iron-hull steam mail-packets (ships) plying up and down the river Seine



Nikola Tesla, the Famous Electric Inventor, Has Proposed Three Different Electrical Schemes for Locating Submerged Submarines. The Reflected Electric Ray Method Is Illustrated Above; the High-Frequency Invisible Electric Ray, When Reflected by a Submarine Hull, Causes Phosphorescent Screens on Another or Even the Same Ship to Glow, Giving Warning That the U-boats Are Near.

BRITISH WOUNDED HEAR LONDON'S FAVORITES VIA TELEPHONE.

The free Electrophone Service, contributed by public-spirited people of London to the hospitals in that city, includes an installation by which a hundred patients can listen, whilst lying in bed, to the performances transmitted from the stages of the leading musical comedy theaters and music halls in London. The accompanying illustration shows some patients, with their mascot enjoying a performance. It is probable that some similar arrangement will be made in this country when the regular and auxiliary hospitals become filled with wounded soldiers and sailors. The telephone has made unprecedented strides in America where there are more telephones per capita than in any other country in the world. There are more telephones in New York City than in all Europe.

Hence, with such extension telephone facilities available, the American convalescents will surely fare as well as their allies. Connection with band and orchestra concerts would seem very suitable.

Photo by Central News Photo Service

The Hospitals of London, England, Are Fitted with Special Telephone Instruments So That the Wounded Soldiers Can, As They Lie In Bed, Listen to the Latest Music Direct from the Theaters and Music Halls. Even the "Mascot" Enjoys It.

ELECTRICITY AND MILK PRODUCTION.

The shortage of milk, due largely to difficulties of transport, suggests another field of agricultural work where electricity can do good service. The transport of milk and agricultural produce is largely a matter of providing light electric railways. In the pastoral districts in parts of Wales and Ireland, for example, facilities for carrying such produce are almost non-existent, and this has always been a check on agricultural production, as well as potential industrial resources. In the dairy electrical appliances have fully justified their value, and it only requires electric power to be available for them to be much more used. The prejudice against the milking machine has now been largely overcome, and experts believe that its action is more reliable than milking by hand, especially as skilled milkmaids are now difficult to obtain in England and Ireland. Refrigerating machinery, again plays a great part in preserving milk and enabling it to be transported for long distances, and electrically driven centrifugal separators for removing the cream are great time savers. The use of mechanical methods is also of assistance in maintaining cleanliness and in sterilization.

The electrical dairymaid is growing to be more of a reality every day, especially in the United States.

---

at a distance of *3 miles* would distinctly affect the galvanometer!"

"How could this be applied to the submarine problem?" I asked.

"Well, for one thing," the scientist replied, "I believe this *magnetic* method of locating or indicating the presence of an iron or steel mass might prove very practical in locating a hidden submarine. And it is of course of paramount importance that we do find a means of accurately locating the sub-sea fighters when they are submerged, so that we can, with this information, be ready to close in on them when they attempt to come to the surface. Especially is this important when several vessels are traveling in fleet formation; the location and presence of the enemy submarine can be radiographed to the other vessels by the one doing the *magnetic surveying* and, by means of nets in some cases, or gun-fire and the use of hydro-aeroplanes sent aloft from the ships, the enemy under water stands a mighty good chance of being either 'bombed,' shelled or netted.

"However, a means would soon be found of nullifying this *magnetic detector* of the submerged undersea war-craft. They might make the 'U-boat' hulls of some non-magnetic metal, such as copper, brass, or aluminum. It is a good rule to always keep in mind that for practically every good invention of such a kind as this, there has always been invented an opposite, and equally efficient counteracting invention."

"How about this new *electric ray* method of locating submarines?" I ventured to ask.

"Yes, yes, I am coming to that," the master electrician parried. "Now suppose that we erect on a vessel, a large rectangular helice or inductance coil of insulated wire. Actual experiments in my laboratory at Houston Street (New York City), have proven that the presence of a local iron mass, such as the ship's hull, would not interfere with the action of this device. To this coil of wire, measuring perhaps 400 feet in length by 70 feet in width (the length and breadth of the ship) we connect a source of extremely high frequency and very powerful oscillating current. By this means there are radiated powerful oscillating electro-static currents, which as I have found by actual experiment in my Colorado tests some years ago, will first affect a metallic body (such as a submarine hull, even tho made of brass or any other metal), and in turn cause that mass to react inductively on the exciting coil on the ship. To locate an *iron* mass it is not necessary to excite the coil with a high frequency current; the critical balance of the coil will be affected simply by the presence of the magnetic body. To be able to accurately determine the direction and range of the enemy submarine four exciting inductances should be used. With a single inductance, however, it would be possible to determine the location of a submarine by running the ship first in one direction and then in another, and noting whether the reactive effect caused by the presence of the submarine hull increased or decreased. The radiating inductance must be very sharply attuned to the measuring apparatus installed on the ship, when no trouble will be found in detecting the presence of such a large metallic mass as a submarine, even at a distance of 5 to 6 miles; of this I feel confident from my past experiments in the realm of ultra-high frequency currents and potentials."

"What particular experiments do you have in mind, Dr. Tesla?" I asked.

"The Colorado tests of 1898-1900. Wonderful were the results there obtained, both those anticipated as well as those unexpected. As an example of what has been done with several hundred kilowatts of high frequency energy liberated, it was found that the dynamos in a power house six miles away were repeatedly burned out, due to the powerful high frequency currents set up in them, and which caused heavy sparks to jump thru the windings and destroy the insulation! The lightning arresters in the power house showed a stream of blue-white sparks passing between the metal plates to the earth connection. I could walk on the sand (ordinarily considered a very good insulator) several hundred feet from my large high frequency oscillator, and sparks jumped from my shoes! At such distances all incandescent lamps glowed by wireless power, and banks of lamp, connected to a few turns of wire arranged in a coil on the ground, were lighted to full brilliancy. The effect on metallic objects at considerable distances was really remarkable."

I asked him about the "Ulivi ray," which was accorded considerable newspaper publicity some time ago.

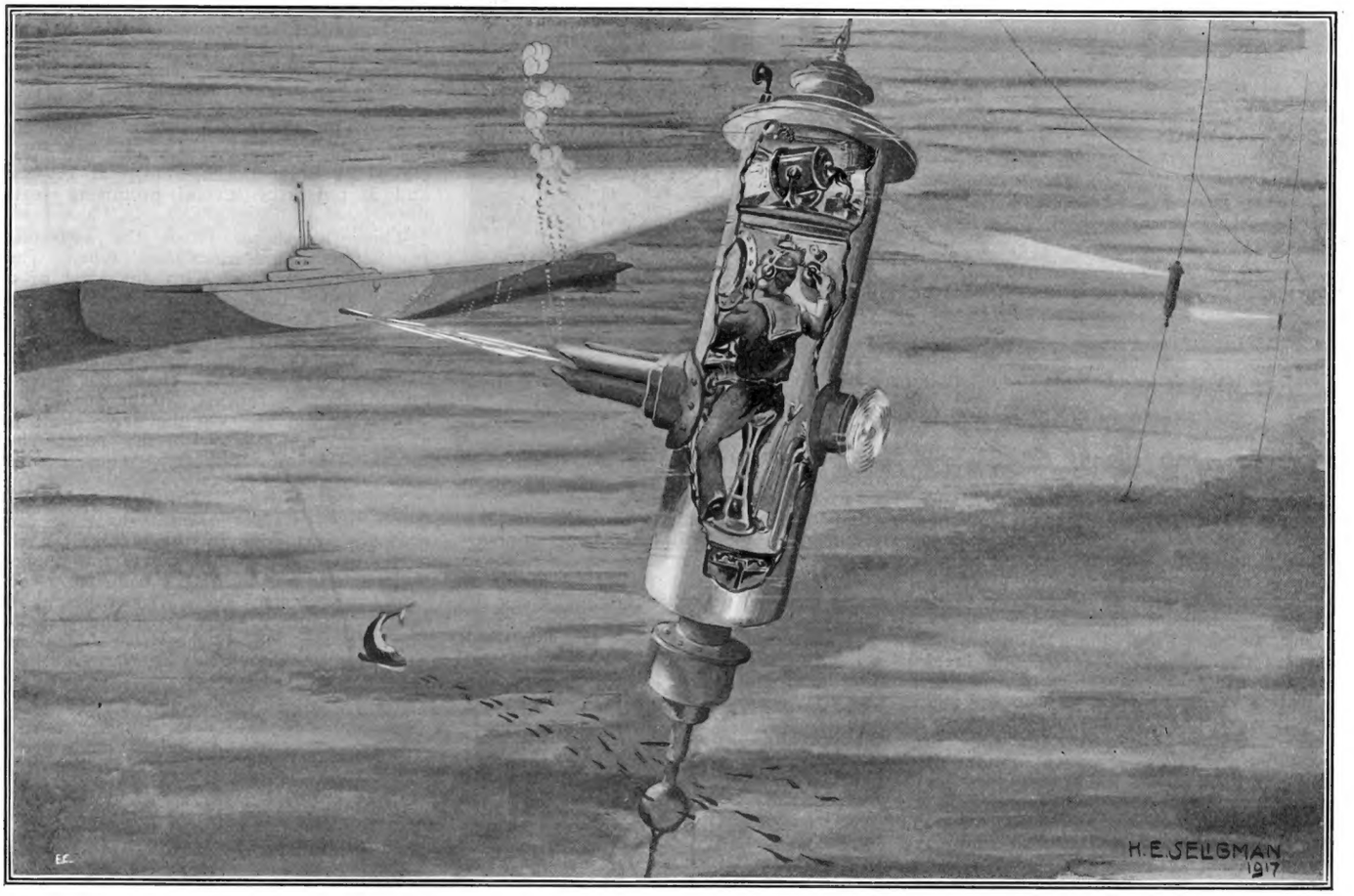
"The 'Ulivi ray' really was transplated from this country to Italy," asserted Dr. Tesla. "It was simply an adaptation of my ultra-powerful high-frequency phenomena as carried out in Colorado and cited previously. With a powerful oscillator developing thousands of horsepower it would become readily possible to detonate powder and munition magazines by means of the high frequency currents induced in every bit of metal, even when located five to six miles away and more. Even a powder can would have a potential of 6,000 to 7,000 volts induced in it at that distance.

(*Continued on page 270*)

Electric Submarine Forts to Destroy Submarines

A NOVEL method of destroying the stealthy submarine is here illustrated and described. It is the invention of Mr. H. Hartman, a consulting engineer of New York City, whose Submarine Camera, Electric Speaking Clock, Automatic Electric Light Buoy, Automobile Direction Signal, *et cetera*, have been described and illustrated in previous numbers of THE ELECTRICAL EXPERIMENTER.

The present invention relates to a Submarine Exploration Device which originally has been intended only for the purpose of conducting submarine exploration and salvage operations at such depths of the sea which are beyond the reach of a diver, but this device can also be adapted successfully for warfare against enemy submarines and especially for the protection of entrances to harbors, rivers, bays and more or less narrow water-ways as well as for the defense of vital parts of the coast.



"Why Not Mine Harbor Approaches and Other Shallow Waters with a Series of Submarine Forts Like Those Here Shown?" Asks a New York Inventor. They Would Carry Powerful Sub-sea Searchlights, Microphones, Telephone (Connecting with Shore Station), and Special Torpedo Tubes for Torpedoing the Enemy Submarines, Should They Come Within Range.

This device, on which the U. S. Patent Office has granted letters patent to Mr. H. Hartman, consists mainly of a vertically arranged strong steel cylinder of 25" to 30" inner diameter which can be closed water-tight at the top, providing sufficient room for an operator and also containing within special compartments a powerful electric search-light, a storage battery, a photographic camera, the appliances necessary for the absorption of the carbon dioxid exhaled by the operator as well as for supplying the oxygen required to revitalize the air within the operator's chamber, and a number of instruments like water-pressure gage, volt and ammeters, switches, telephone, etc.

Attached below the main cylinder is an auxiliary casing, closed watertight and containing a second storage battery for the purpose of overcoming the buoyancy of the main body. This auxiliary casing can be dropt at will by the operator in case of emergency; for instance, if the wire rope from which the whole device is lowered into the water should break, in which case the main body would rise by buoyancy to the surface of the water.

Furthermore, there is provided at the rear of the main cylinder an electrically operated screw propeller which will rotate the whole suspended (or anchored) unit round its vertical axis if desired by the operator. The main cylinder is divided into three separate compartments as is shown in the picture. The lowermost compartment contains a storage battery of high capacity and sufficient evacuated space to take up any gas which the battery may develop during its discharge action.

Hermetically sealed from this compartment follows the operator's chamber in which a man may comfortably ride on an elastic saddle and observe the surrounding waters thru a system of heavy lenses which are set carefully and watertight into the steel cylinder. To illuminate the water a very powerful electric searchlight is arranged within the next or top compartment, which in its turn is also divided from the operator's chamber by a water-tight partition, so that no water can enter the same in case that the large lens thru which the light is projected into the water should break under the high pressure prevailing at great depths. The water-tight cover of the main cylinder contains a special cooling arrangement which is required, as otherwise the heat emanating from the light projector would rise to a dangerous degree, which could cause the bursting of the large lens; nevertheless the same is protected by an inner circle of transparent mica with small openings thru which the heated nitrogen gas, filling this compartment, may only gradually and slowly circulate before striking the large lens which is cooled from outside by the icy waters of the depth.

The operator can not only swing the light projector under different angles by means of electro-magnets but also rotate the whole device slowly round its vertical axis and incline the same to a certain degree and observe the surrounding water in every direction. A telephone connection, whose insulated conductors are embedded into the core of the wire rope from which the device is suspended into the water, permits the operator to remain in constant communication with his mother ship and to report at once everything he sees and also to direct salvage operations, when so used. The submarine fort can also be anchored as shown, the top cable running to a submerged buoy. A string of these forts could be placed across the entrance of a harbor or bay.

(*Continued on page* 270)

Putting the Ocean Waves to Work

By CHARLES W. GEIGER

IF there is any one invention that has been well-nigh worked to death, it is that which tends in some way or other to make practical use of the boundless energy in the ocean waves. But, regardless of all the study and work that has been expended on this engrossing and worthy problem, all attempts up to the present time have signally failed to produce any satisfactory results in putting these ever-rolling walls of water to work. It must have exasperated many an engineer to see this tremendous power continually going to waste. But indomitable courage and resourcefulness will overcome almost any obstacle as long as it comes within the pale of practicability.

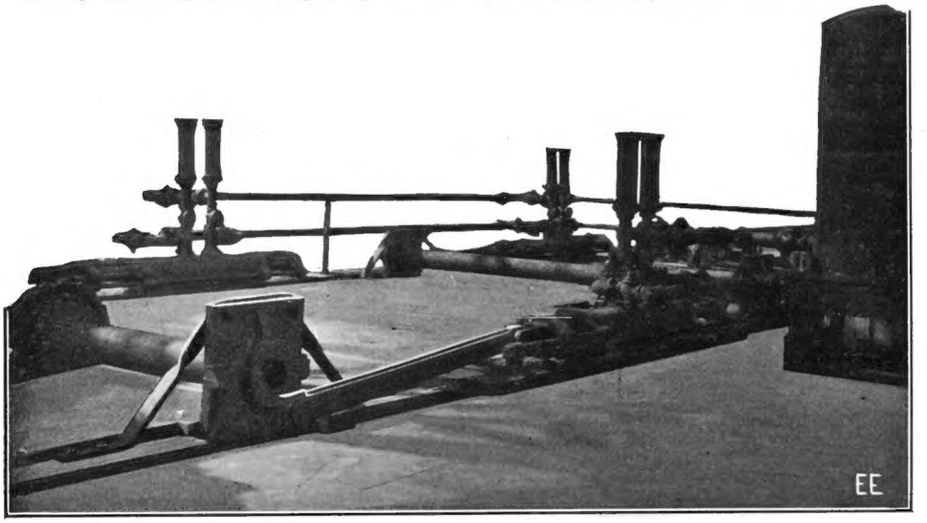


Fig. 2—Another View of the Hydraulic (Compound Pump and Turbine) Type of Wave Motor Shown Below. Depending Paddles Are Actuated by the Waves and Every Bit of Motion Is Put to Useful Work.

Just to show that there is a way to harness the industrious waves and breakers, two California inventors have worked out what seems to be a start in the right direction, as the accompanying photographs bear testimony, illustrating as they do, two distinct types of wave motors installed at Long Beach, California. They are intended to develop considerable power and to show that it is possible to develop electrical energy more cheaply than by burning coal or by other means. The view, Fig. 1, shows the extensive wave power plant now being installed in commercial capacity at Long Beach, California. The wave motor here presented displays a wide divergence from the wave motors of past experimentation.

The unique feature of this new machine is a compound uni-directional or free-draw and release clutch. This clutch is an achievement in rotating a power shaft in such a manner as to free the same from all dead center action, as well as creating rolling energy with the condition of no given stroke. So perfect is the action of the clutch employed, it is said, that any vibrational action is immediately transformed into a continuous rotary impulse. The machinery employed utilizes for its driving energy the reciprocating action of the ground swell occurring in ocean water. This action being caused by volumetric displacement as the wave moves forward setting up compound actions in opposite, a feature that no other motor possesses.

Substantially the machine consists of a multiple number of large *bull-wheels* each actuated by an *impulse paddle*, well covered by water at low tide. These wheels, by the merit of the novel clutch used, have an absolute freedom and independence one from the other, even tho they play on a *common* power shaft. In this manner any vibrating tendency of the swell is immediately disposed of as driving energy on power generating units. The machine now being installed will, when fully completed, present an ultimate capacity of some three to four thousand horse-power.

This machine, aside from presenting the required feature of being a continuous power producer operating irrespective of surface action, also possesses the merit of being a storm resistant machine, being the only one of its kind having no resistance to start, and at no time experiencing back pressure effects. The device was thoroly tested and proven by the operation of a demonstrating plant which experienced the action of two of the heaviest storms that has occurred on the Pacific coast for a period of twenty-five years, without the slightest damage.

With its wave power equipment the company anticipates the production of electric energy on a wholesale basis, at about 90% of the cost of production by steam, and 75% of the cost of production by present-day hydro-electric methods. According to the best of authority it will be possible even under the present strest condition of the steel market to install these plants at the surprising figure of $30.00 per horse-power.

In actuating the power shaft, oscillating *bull-wheels* are connected by heavy ¾-inch plow-steel cables, which engage the impulse wheels actuating the clutch units by multiple series of turns on the same. By direct connection on side and reverse connection on the opposite side, the continual rotation of the power shaft is readily maintained. The bull-wheels employed in driving the power shaft are of a six-sector bridged arc type, 24 feet in diameter, built to resist fractious stress on two one-inch steel cables. These wheels are so disposed as six units to incorporate within the machine the action of two ground swells at any one time, taking varied action so as to afford a steadied maintenance of power at all times.

Mr. Alva L. Reynolds, the inventor of the second type of wave motor being installed at Long Beach, shown at Figs. 2 and 3, possesses several promising features.

This wave-motor is of the *hydraulic transmission* and *regulation* type. The paddles are actuated with any kind of a wave, and either forward or backward movements of the paddle are transmitted into energy. The paddle is connected to a pendulum shaft with a sprocket as shown. This sprocket actuates a chain that is connected with a sprocket on the shaft that drives the pumps. On the drive shaft is a crank connected with the pumps by means of a connecting rod. These pumps were designed for this special work in this special position. The chain and cog-wheel that drives the crank-shaft is seen near the left edge of the picture. Each movement of the paddle moves this crank-shaft and by means of the connecting rod works the pumps. There are two pumps to each pendulum. There is another crank-shaft on the end of the drive-shaft that

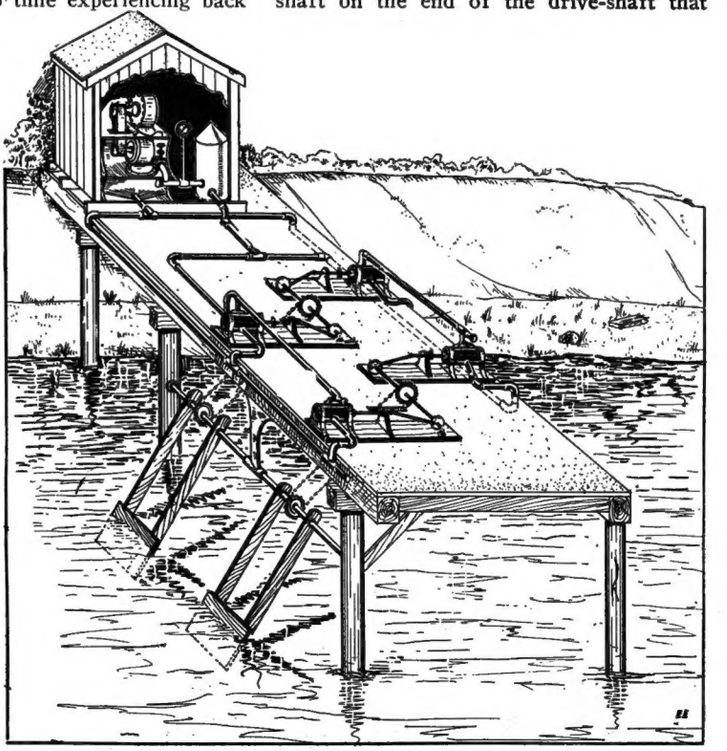


Fig. 3—Perspective View of New Hydraulic Transmission and Regulation Type of Wave Motor Installed At Long Beach, California.

actuates the pump seen to the left of the picture. There are four pumps altogether in this unit and two pendulums.

As the water is comprest by the pumps, it passes thru a large pressure tank (seen to the right in the large picture). This takes the pulsating effect of the pumps out of the water and leaves a perfectly steady stream for the water wheels. This water, under 120 pounds pressure, runs a water turbine which in turn is connected to the electric generator.

Fig. 1—A Second Type of Wave Motor Being Installed At Long Beach, Calif. The Waves Actuate Dependent Paddles Attached to the Large Bull-Wheels (Top Photo). Continuous Rotary Motion Is Obtained by the Remarkably Sensitive Free-Draw and Release Clutches Used (Lower View).

The power thus generated is at present used for lighting purposes and for a large search-light. The generator is also connected to storage-batteries, which are charged when there is plenty of water power in preparation for the time when the ocean may be comparatively calm.

SELENIUM SPEEDS UP THE OCEAN CABLE.

A new invention, devised by Mr. J. B. Dixon, has been in practical operation on certain of the Atlantic cables, and is reported to have given remarkable results, the speed of operation in the commercial handling of cable messages has been increased upwards of 125 per cent, while in tests far greater speeds have been attained. The gain in speed is due to the use of selenium cells to amplify the signals received, and to the use of means for obtaining, from one or more sources of illumination, a very large number of light beams, concentrated coincidently upon selenium cells, and deflected by a line galvanometer across the surface of the cells, the effect being that a very intense illumination of the cells is obtained.

It is found that the practicable speed of operation increases as the intensity of illumination increases. The selenium cells operate a siphon recorder or a relay. There being no physical connection between the recorder or relay and the line galvanometer, the inertia and frictional losses present in the older magnifying and recording apparatus are largely eliminated, the more so as in the new system the amplitude of vibration of the galvanometer coil is, in general, much less than in the case of the older apparatus. It is stated that Mr. Dixon employed 45 separate light beams, all derived from one 400 candle-power tungsten lamp, and all concentrated on a thin galvanometer mirror 5 inches long and ⅜ inch wide. These light beams were reflected from the galvanometer mirror, in one case, a distance of 7 feet 6 inches, and were then reflected a further distance of 7 feet 6 inches to the selenium cells, the light beams being concentrated coincidently upon the cells.

With this apparatus, working over one of the transatlantic cables the normal rate of operation of which is less than two hundred letters per minute, a speed of 450 letters per minute and higher was obtained in the regular commercial handling of business, and still higher speeds have been obtained on tests, with signals fully readable as to size and character.

GROWTH OF ELECTRIC STEEL FURNACE INDUSTRY.

In 1908 there was one electric steel furnace in the United States with an annual production of 55 tons. January 1st of this year there were 136 furnaces reported, as compared with 73 in use in 1916. The electric furnace can no longer be said to be in the experimental stage, with 20-ton furnaces in regular operation.

ELECTRIC TRAPSHOOTERS WHO "NEVER MISS" ARE NO MORE.

For the past 16 months, from sunset to sunrise, the electrically operated trapshooters on the world's largest, most attractive, realistic and spectacular electric sign—located on the Million Dollar Pier, Atlantic City, N. J.—have fired at 10 targets a minute and recorded a "hit" every time.

Human trapshooters are not equal to the task of breaking every target thrown. Mechanisms, of course, can be made almost infallible, but mark you, from now on, the electrical trapshooters are to be more realistic and more human than ever. They will miss at irregular intervals. *Irregular* is the proper word.

Thousands of persons seat themselves on the spacious hotel verandas and many more mass on the boardwalk every night trying to figure out when the shooter will *miss*. Sometimes the misses are as many as two or three in thirty seconds—while at other times the misses are not more than two in the same number of minutes. Therefore it is difficult to work out a system and play it.

Figuring out "when the shooter misses" has become quite a game in Atlantic City, and every one is playing. You cannot help but enthuse and get into the game after watching the electrical display. It is only human to try and solve the puzzle—and ascertaining just when the shooter misses is a puzzle. Thousands check up the misses each night, keeping tabs by the hour, but on no two nights thus far has the rotation of misses been the same.

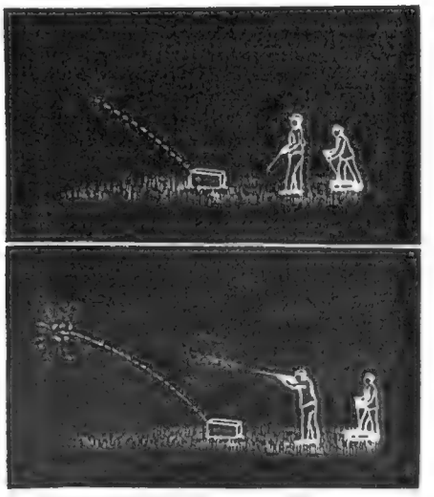
It took five months of incessant scheming and testing to perfect the scheme of having the shooters miss, and the changes had to be made so as not to affect the operation of the sign. The iron work was extended 10 feet and several hundred additional lights are now in operation.

This is the second change that has been made in the working of the great sign since it was first shown to public view—January 4, 1916. The original shooter was a man. Then the idea was suggested to have a woman alternate with the man in firing at the targets. This wonderful accomplishment was perfected and the fair Diana began alternating with the male shooter several months after the first operation of the sign.

There are 4,000 lights in the entire sign, which is 50 by 100 feet. The figures of the shooters are 21 feet high. The trap puller is 18 feet 6 inches tall. The target is 15 inches in diameter. The sign cost upwards of $100,000.

There are six operations to the sign, each one taking about one second. First the green lights come on, producing a lawn effect, and then in order appears the trapshooter, who places his gun to his shoulder and aims as the trap puller rises behind him. The puller throws the lever, which releases the target. You soon learn whether the target is hit or mist. When hit, the target bursts into hundreds of small lights, looking for all the world like the fragments of a target. When the target is mist it travels the length of the sign and disappears into the fourth dimension—inky blackness.

It is a most interesting display, and has proved the only means so far of grafically depicting the actual sport of trapshooting by mechanical effects.—*Photos courtesy of R. C. Maxwell Co.*



Atlantic City Crowds Are Now Kept Busy Figuring When the Electrical Trapshooter Is Going to "Miss."

Blinding The Submarine

By H. GERNSBACK

THERE is one dead sure way of making a ship torpedo-proof and that is by making it invisible. No one will deny this. For if the submarine commander can't see his quarry he can't torpedo it. Now, this is not intended as a joke, nor do I refer to Grimm's Fairy Tales, where the young prince by the turn of his magic cap becomes invisible to all. Rather I wish to stay within the realms of common physics, and present day physics at that.

After all, what is visibility? It is that which is perceptible to the eye. A ship visible in broad daylight is invisible in a dead black night. But visibility depends upon sight, so that a ship visible to you in broad daylight is invisible to the blind man. All this is obvious.

Our problem as applied to submarine warfare then resolves itself in blinding the submarine commander, so that he cannot see the ship he wishes to attack. Can this be done? I am certain of it. And what is more, the plan which I advance herewith is so idiotically simple, that probably just on account of its very simplicity it has not been tried before. It is the old story of Columbus and the egg—it is simple if you know.

In order to understand what I mean let us try a few simple experiments.

EXPERIMENT 1. Light up a powerful auto searchlight tonight, *only one tho.* The auto must be in the dark. Now station yourself 50 yards away. Do not look directly into the shaft of light. Can you tell *where* the driver sits? You cannot. You simply see the light shaft, that is all. But you can't see *where* the car is, and whether it is the right or the left searchlight that is lighted.

EXPERIMENT 2. Have an assistant throw the full glare directly into your eyes. You will be blinded for several seconds.

EXPERIMENT 3. Try experiment 2 in broad daylight, but with the searchlight detached from the auto. Ask your assistant to move to one side of the car. Have him train the full glare into your face. It will be impossible for you to see the car, but you cannot see the objects to either side of your assistant—even in full daylight—because the darkened glass does not pass thru enough light.

You readily understand these experiments, and they are correct as stated, having been actually tried out in New York City by us. "But, what is the good of them," you will ask. Here is the answer:

Consider that the submarine commander, in order to look thru his periscope, must of necessity be in the dark, or at least his quarters immediately surrounding him must be more or less subdued and shielded from light. You know you cannot look thru a telescope at a distant object without even with the sun shining on it. You are blinded in broad daylight. This, of course, providing that the searchlight is sufficiently powerful. If you don't own a searchlight try a mirror, and have your assistant reflect the sunlight into your eyes. *Try as you may, you will never as much as glimpse an object within* 500 *feet of either side of him.*

EXPERIMENT 4. Repeat experiment 3, but protect your eyes by black glasses (smoked glasses). You will find that it won't help you at all. Instead of a ball of white fire you now get a ball of orange fire into your eyes. Less blinding, true—placing your eye close to the eye-piece, in order to shield your eye from the light. Now then imagine for a minute that you are the submarine commander, with your eye glued to the as yet submerged periscope. Slowly and cautiously you raise the periscope tube till it is a foot or more above the water. Rapidly you turn it in a circle to scan every point of the horizon. Nothing but the blue sky and the ocean. You keep on turning. Suddenly like a bolt of lightning your eyes are filled with a ball of white fire that makes your eyes water.

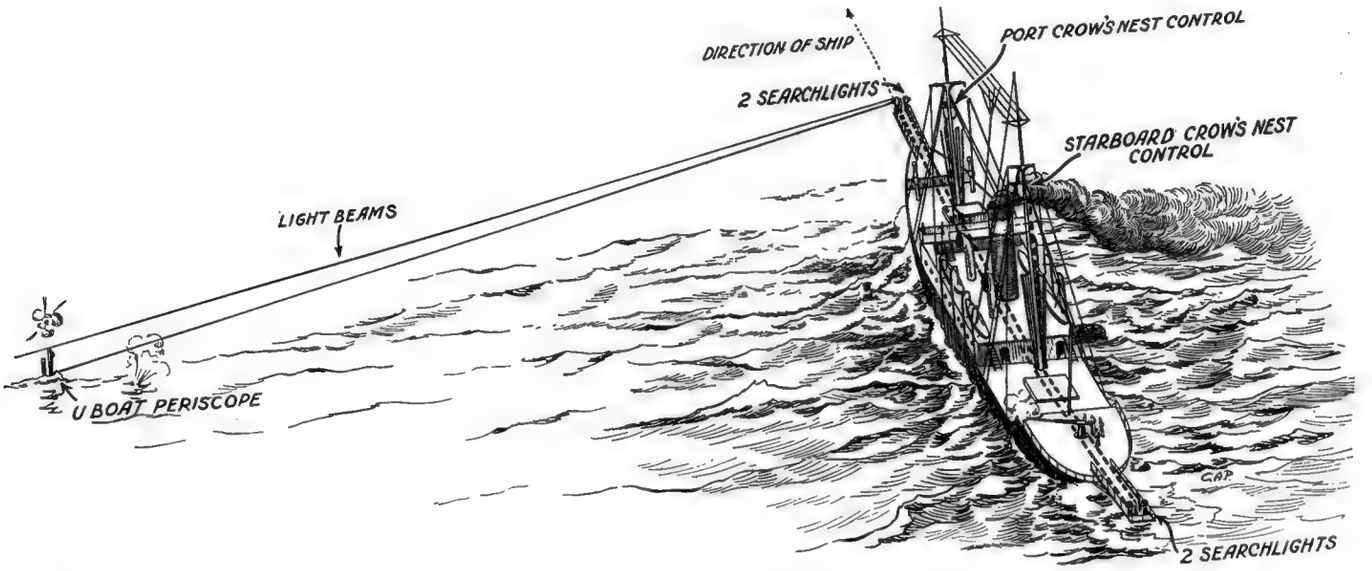


Fig 1. Keeping Very Powerful Searchlights Trained On the U-Boat Periscope, Makes It Impossible for Its Commander to Take the Attacked Ship's Bearings. The Searchlights Are Used In Broad Daylight. Now See Fig. 2.

When a U-boat Commander wishes to torpedo your ship he must know three things:

1st He must know the speed of your vessel.

2nd He must know in which direction you move.

3rd He must know the distance measured in a straight line from the U-boat to your ship.

If you devise a means whereby he cannot make his observations correctly, the commander will be unable to torpedo you. The idea outlined in this article aims to blind the U-boat commander in broad daylight by means of powerful searchlights, thereby making it impossible for him to correctly take a ship's bearing.

An interesting as well as plausible article, that will set you thinking.

"Donnerwetter!" you will say—presuming that you are a German U-boat commander. Down comes the periscope, while you wipe your eyes stupidly. After a few minutes you try again. Once more you are blinded for seconds at a time. You see the light but that's all.

Now to torpedo a ship you must know several things. First you must know its position, that is how far away it is from you. Second, you must know in what direction the ship is traveling. Third, you must know its speed. Without knowing these three things it is as a rule impossible to torpedo successfully.

And with a powerful searchlight trained full on your periscope you would of course

know where the ship was, but you could not possibly know how far away it was from you as measured in yards, nor would you know if the ship was traveling *towards* you or *away* from you. You could not know if the searchlight was on the bow or on the stern of the vessel. Neither would you know if the ship was traveling at right angles to you or whether it presented its bow or stern to you. Artifices such as sensitive microphones will not help you much. You must take the ship's bearings accurately or you cannot possibly torpedo it; any naval man versed in submarine matters will confirm this. As long as the glare persists you cannot take your bearings. And you don't dare come up to the surface to walk on deck of the U-boat, because the ship that has the searchlight, most likely will have guns too. So you curse a full round, haul down the periscope for the ninth time and drown yourself in a *stein* of *Würzburger*.

My idea then is this. Mount on the ship four powerful searchlights. Our illustration shows how it should be done. There should be one attendant to each searchlight. Ordinarily the searchlights are not lighted but remain dark. Each searchlight operator wears a telephone headgear, exactly as our naval gunners do now. Stationed high up in the crow's nest are two observers scanning the water at all times with their glasses. One observer scans the ocean on the starboard side, the other overlooks the water on the port side of the ship. Strapt to their breasts is a transmitter, the same as "Central" wears. The instant the top of a periscope is observed, let us say on the port side, the crow's nest immediately gives the position to the two port searchlight attendants. By means of a foot operated switch, the current is turned into the searchlight instantly and the latter is trained onto the periscope. The searchlight being placed on ball or roller bearings, obeys the touch of the finger. Thru a sighting tube the attendant will positively throw the glare full onto the periscope *in less than five seconds* after he received the position from above. Very great accuracy is not necessary for these simple reasons:

Let us assume the U-boat is two miles off. At this distance the beams of the searchlight cover a fan-shaped expanse of about 50 yards. In other words, if the attendant makes a mistake of 25 yards on either side of the periscope, it does not matter; the U-boat commander will be blinded just as efficiently. Besides, the man behind the searchlight will correct his aim in less than three seconds, once his rays have hit the periscope.

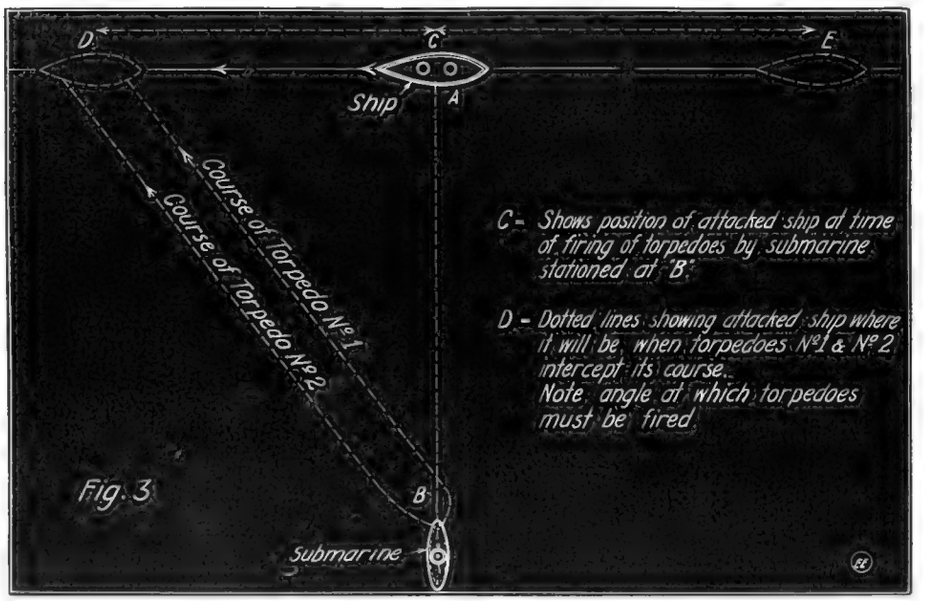
Observe the simplicity of the operation. A hundred percent hit should be recorded every time. It is inconceivable how either of the two attendants could fail to make a "hit" with their rays. Note, too, that the operation is unlike firing a gun. First, considerable time is lost in sighting the latter; second, to hit an object one foot high and six inches in diameter (the enemy periscope) with a two or three inch projectile is almost an impossibility. It has never been done, except by pure chance. One hit in a thousand would be considered good. Consider, on the other hand, a shaft of light 50 yards wide, which can be moved *instantly* over an expanse of several miles, and it becomes plain why there cannot be possibly any escape for the periscope.

The beauty of the scheme is the great speed at which the entire operation is performed. Five to six seconds—and with a trained crew it should be less—is ample time once the periscope is located. No submarine commander can possibly make his necessary observations in such a short time; it requires a minimum of *one minute* to take a ship's bearings.

Of course it is evident that the success of the scheme lies in the ability of the lookout, who must spot the periscope at once. This, however, should not be so difficult for a trained seafaring man.

I mentioned above that two searchlights could and can be used simultaneously. For practical purposes and for tactical advantages a single searchlight, however, is preferable for the following reasons:

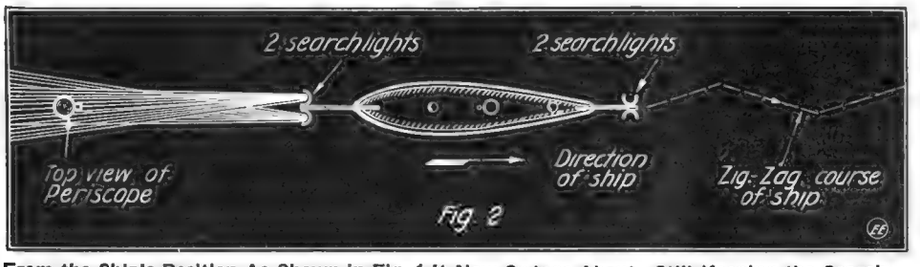
Our front cover shows how the searchlights are mounted on a long steel extension projecting some 25 feet from the bow and stern of the ship. This is done for two reasons. First, it gives the operator a better sweep, second and most important, if the submarine commander should fire a torpedo in the direction of the light rays, even if he has the general position of the searchlight, he probably would miss the ship by a great many feet, due principally to the extended location of the searchlights. This is not apparent at once but bear in mind that the commander *does not see the ship itself,* and that *he does not know if the beam of light originates from the bow or from the stern of the vessel* to be torpedoed. Neither does he know in which direction the ship moves. Then, too, as soon as the enemy periscope is sighted and has been covered by the light beam, the ship can turn about at once, the searchlight's rays however being kept on the periscope all the while during this maneuver. If the periscope is hauled down, the operators have but to watch for its reappearance, when the game starts anew. In the meantime the commander of the ship can either "zig-zag" his ship or else present the stern of the ship towards the U-boat. In either case torpedoing is extremely doubtful, and the attacked ship should make good its escape.


D
C
E
Ship
A
Course of Torpedo No. 1
Course of Torpedo No. 2
C - Shows position of attacked ship at time of firing of torpedoes by submarine stationed at "B"
D - Dotted lines showing attacked ship where it will be when torpedoes No. 1 & No. 2 intercept its course. Note angle at which torpedoes must be fired
Fig. 3
B
Submarine

To Torpedo a Ship the Submarine Commander Must Know These 3 Things: 1st, Distance from A to B in Yards; 2nd, Speed of Ship, i.e., How Long it will Take to Travel from C to D; 3rd, Direction in Which Ship is Moving, i.e., Does it Travel from C to D or from C to E?

The scheme as outlined is for use in broad daylight, or rather during the daytime, but I doubt if it is feasible or practical at night. Nor is it necessary, for only comparatively few boats are sunk between sunset and sunrise. Of course in clear moonlight or in extraordinarily clear nights where the visibility is not too low, the searchlights can be used to advantage. In a very dark night, however, it is obvious that the U-boat possesses a great advantage over the ship. It is then almost impossible to sight the small periscope, and the U-boat would surely see the searchlight much quicker than the ship's observer could see the U-boat. Still the fact remains that the submarine commander would be baffled, because he could not tell if the searchlight was in the center, in the bow or in the stern of the ship. It is therefore doubtful if he could make a hit, except perhaps by using two torpedoes simultaneously directed fifty yards to either side of the searchlight. But even then a hit is not at all certain, because the ship might present its bow or its stern to the U-boat, thereby offering a very small target. In that case the torpedoes would of course pass the ship on either side of it. The main requirements of the plan as outlined are VERY powerful electric searchlights. Hundreds of thousands of candlepower MUST be used, otherwise the scheme is

(*Continued on page 270*)



From the Ship's Position As Shown in Fig. 1 It Now Swings About—Still Keeping the Searchlights On the Enemy's Periscope—Thereby Presenting Its Narrowest Part to a Possible Torpedo. Then By Zig-Zagging, the Attacked Steamer Can Escape.

Thunder-Storms and Lightning Rods

By TERRELL CROFT

THIS matter of thunder-storms and lightning rods is one about which many inaccurate impressions exist. Altho the lightning rod is the oldest useful electrical invention (it was first proposed by Benjamin Franklin in 1752) it has been the writer's experience that, today, a majority of otherwise well-informed folks do not know whether or not lightning rods afford protection to the buildings on which they are installed. The subject is one of such universal interest that everyone should be familiar with the general facts relating to it. Therefore in this article the essential and underlying principles as they are explained by the modern theories will be discust.

There are no experiments which the reader can readily perform to verify the facts disclosed in this article because the electrical qualities involved in lightning phenomena are of such great magnitude that they cannot be accurately reproduced in the laboratory. In this instance he must, without verification, take the author's word for it that the statements which will be made are correct.

First of all, lightning rods *do,* when they are properly installed, afford practically perfect protection against lightning damage to structures. The United States Government Bureau of Standards finds that even as they are ordinarily installed—and they are not always in practise arranged as effectively as should be—lightning rods "reduce the fire hazard from lightning by 80 to 90 per cent in the case of houses, and by as much as 99 per cent in the case of barns." Inasmuch as something more than $8,000,000 worth of property is destroyed annually by lightning in our United States (practically all of this loss could be prevented by the suitable lightning-rod installations), the importance of the subject is apparent.

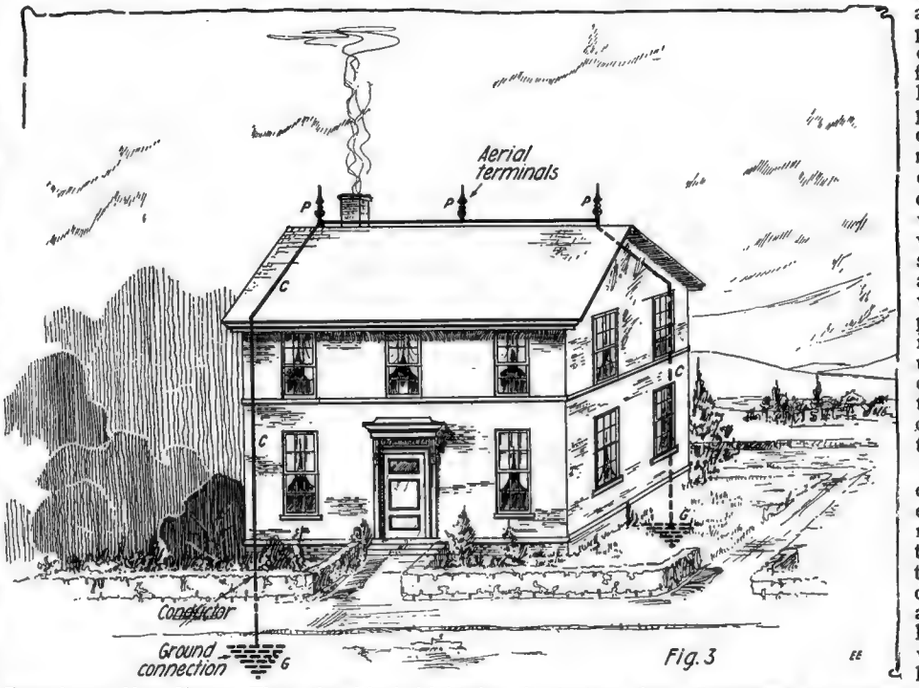
Now that we understand the fundamental dollars-and-cents feature affecting this situation, let us examine the causes of thunder-storms and lightning and find out how and why lightning rods afford protection.

What is it that causes lightning and thunder-storms? That is, how do the unusual electrical conditions, which we all know must precede a lightning flash between a cloud and the earth, originate? It is almost apparent that the cloud must be highly electrified—must contain an excess or a deficit of electrons as compared with the earth to cause the lightning flash. But how does the cloud thus become electrified?

No one can now answer this question with absolute definiteness. But we can, thanks to the researches of Dr. George C. Simpson of the India Meteorological Department, Simla, give a logical explanation which is well supported by experimental facts. It is, probable, as will be shown, that the electrification of thunder clouds is due to an excess of electrons in the cloud which electrons have been knocked off, in the base of the cloud, from drops of water by an ascending air current.

It appears that there is always a current of moisture-laden warm air ascending from near the earth to the cloud just prior to a thunder storm.

When this humid warm air current reaches the cold region at the cloud, the moisture in the air current is condensed by the low temperature there and then forms into drops of water. The data collected by Dr. Simpson tends to indicate that the ascending air current then breaks into smaller water particles or minute water globules the drops of water which have been condensed from it.



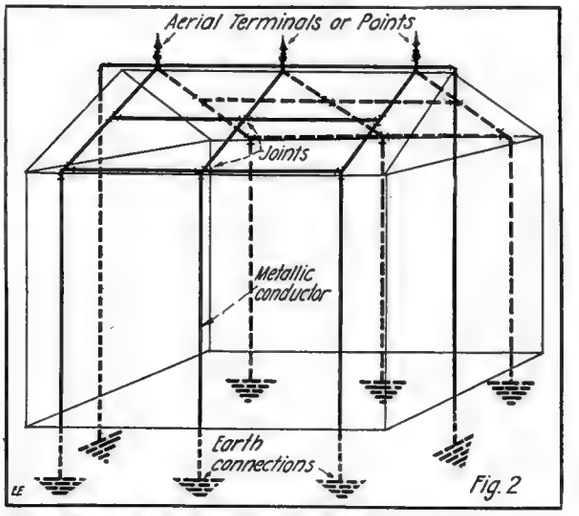
Experience Has Shown That the Ideal Lightning Protection Cage Suggested by Lodge Is Approximated Amply If a House Is Rodded in the Manner Illustrated.

Now it can be shown experimentally that when "drops of distilled water which are falling downward thru an upward air blast of sufficient strength to cause some spray," the water particles and the surrounding air become *electrically charged.* The particles become positively electrified and the surrounding air becomes negatively electrified. In other words, such an air blast appears to knock off some of the electrons, which are, as has been explained, particles of negative electricity. These float about and finally penetrate to all portions of the cloud, charging the cloud negatively thruout its entire volume. The drops of water, from which the electrons were knocked, finally shift or are forced away from the area where they are supported by the ascending air current and ultimately fall to the earth as rain. Thus the entire cloud becomes negatively electrified.

The ascending air current from the earth to the cloud must, in order that the electrons may be torn off from the condensed-water drops, as above described, have a certain upward speed or velocity. And there are other conditions—which it is unnecessary to discuss here—that must be satisfied. But, taken all together, observation of actual conditions leads Dr. Simpson and others, who are well qualified to judge, to believe that the above outlined theory explains in a general way, how thunder-storm clouds become so highly electrified.

Thus when a cloud has become negatively electrified, thru the process above outlined, the situation may then be diagrammed somewhat as shown in Fig. 1. The cloud, *C,* contains many or an excess of free electrons—is highly electrified negatively. The area of the earth, *E,* under the thunder cloud, is in an almost neutral state, that is, practically speaking, it contains neither an excess or a deficit of electrons. Hence, there is a tendency (which is sometimes called an electric pressure or electromotive force) tending to establish an electrical balance between the cloud and the earth. There is a tendency for the excess electrons in the cloud to pass thru the atmosphere between the cloud and the earth to equalize the unbalanced electrical condition due to all of those excess electrons in the cloud.

However, the atmosphere is a non-conductor of electricity or electrons. Hence, the excess free electrons on the cloud cannot pass freely thru the air to equalize the electrical unbalance. (If the air were a good electrical conductor there could be no lightning.) But the tendency of the electrons to pass to the earth does create a stress—an electrostatic field—in the air

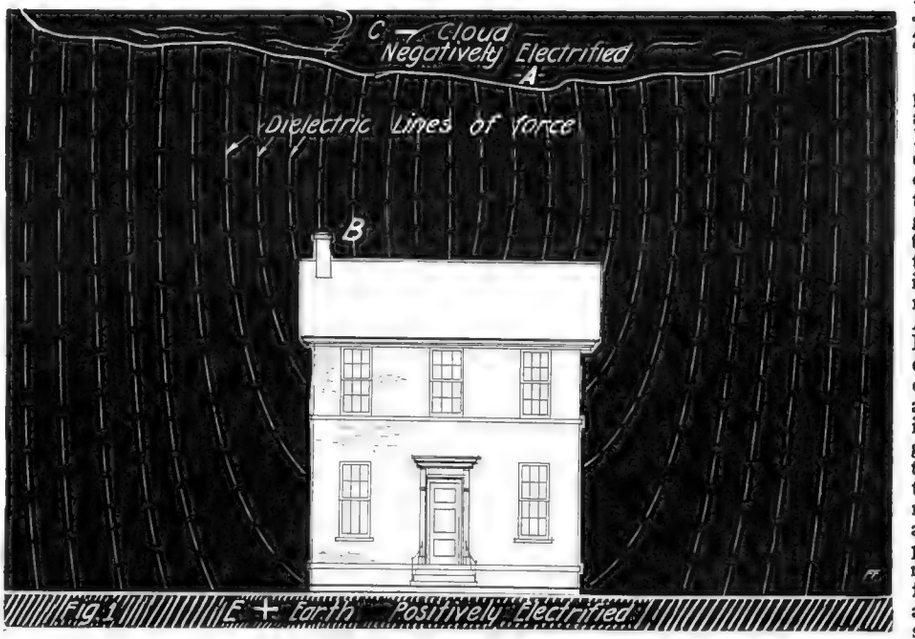


It Would Be Expensive and Unsightly to Install a Complete Inclosing Metallic Cage on Every Building, Altho This Would Afford the Ideal Protection from Lightning.

between the earth and the cloud. This field is represented in Fig. 1 by the dotted lines.

Now, as more and more electrons are knocked off of the water drops by the air current ascending from the earth to the cloud, the electrification of (the number of free electrons in) the cloud increases. The electrostatic stress in the air increases correspondingly. Ultimately, if the separation of the electrons from the water drops continues, the layer of air insulation between the cloud and the earth breaks down—it is ruptured—and then the free electrons in the cloud do flow to the earth and the flow is an *electric current*. Such an electric current thru the air produces what we call *lightning*, or a lightning flash.

The "break down" thru the air between the cloud and the earth will occur at the path of least opposition. Usually the path of least opposition—the shortest path electrically—is between a portion or knob of the cloud protruding from the lower face of the cloud and the upper end of some semi-conducting object extending up from the surface of the earth. Thus, with conditions as shown in Fig. 1, the lightning flash would probably occur between *A* and *B*, this being the shortest path. However, for reasons which it is unnecessary to discuss here, the shortest path in feet between the cloud and the earth is not necessarily the one of the least opposition.



Elementary Representation of the Electrostatic Stress Existing Between the Earth and a Charged Cloud. When This Stress Reaches a Certain Limit, the Air Insulator Is Broken Down, an Electric Current In the Form of a Powerful Spark (or Sparks) Passes, and We Have a "Lightning" Discharge. Thunder Is the Sound Caused by Lightning.

Thus we now understand what, probably, causes lightning and why lightning usually "strikes" high objects extending from the earth's surface, such as buildings, trees, towers, steeples and the like.

If there is no lightning-rod installation on a building or object and lightning "strikes" it, the lightning-flash current will flow thru some part of the building to the earth. The current, which is always of enormous intensity, may develop sufficient heat to ignite combustible objects in its path. Thus, buildings are set on fire by lightning. When the current flows in a non-combustible material, it may heat the part of the material in its path to very high temperature. Then, almost instantaneously, that moisture which has been absorbed by the material and which lies in the path of the current is turned into steam. An explosion results. It is due to these explosions that bricks, stones and boards are knocked from buildings and trees are splintered and split. Chemical action due to the great current may also play a part in these "explosions."

However, if a building be surrounded by a metallic cage, as suggested in Fig. 2, and it is "struck" by lightning, the metallic conductors will offer a path of such low resistance (as compared with the path thru some poorly-conducting part of the building) that all of the lightning flash current will flow thru the conductors to earth. Then no damage will occur, assuming, of course, that the conductors are large enough so that they will not be melted by the lightning-flash current. We may now understand how lightning rods protect buildings.

It will be very expensive to install a complete inclosing metallic cage like that of Fig. 2 on every building, altho such a cage would afford the ideal protection. Experience has shown that ample protection is provided if only part of the cage is installed on the ordinary building, as shown in Fig. 3. The conductor is so routed over the building as to afford maximum enclosure with minimum material. Aerial terminals or points (*P*, *P* and *P*) are connected to the top part of the conductor system and extend upwardly into the air. The lower ends of the down conductors are grounded as shown at *G* and *G*.

There is not sufficient space available here to give complete directions for the installation of lightning-rods, because if an installation is to be made most effectively there are many things must be considered. In fact the routing and arrangement of the conductor system are the most important features of an installation. Good materials can be arranged and connected so as to provide ineffective protection. A few pointers will be given.

The lightning conductor should not be insulated from the building and its contents. First of all, it is foolish to endeavor to insulate against the enormous voltages to which lightning flashes are due. An insulator that would actually *insulate* against such voltages would be almost as big as a small-sized house. Furthermore, even if it were feasible to insulate the lightning rod system from the building and its contents, it would be undesirable and, in some instances, positively dangerous to do so. The ground connections should be good. The ground conductors should extend down into permanently-moist soil.

As to the best metal for the lightning conductors: Any reasonably good conductor will do, provided the rod is large enough so as to be mechanically strong and so that the lightning-flash current will not melt it. Either iron or copper is ordinarily used. While iron—if big enough—is altogether satisfactory as long as it lasts, copper is much more preferable because it will have a long life under conditions where iron would rust away in a short time. All iron conductors should be protected with a zinc coating to minimize corrosion. A good substantial iron conductor is, doubtless, in most cases, preferable to a flimsy, weak copper one.

The day of the lightning rod agent of ill repute is past. Once, these agents used to ramble over the countryside, selling the unsuspecting farmers anything from a fake lightning rod to a neat parcel containing a "million volts." But the farmer of to-day is educated in electrical matters.

JOINING GLASS AT MODERATE TEMPERATURES.

In a paper recently presented to the Faraday Society, Messrs. Barker and Dalladay described some interesting experiments on the direct joining of glass at relatively low temperatures which they have carried out in the research laboratories of Messrs. Adam Hilger, Ltd., England. The results described are not only of very considerable direct scientific interest, but afford great practical advantages in the construction of glass apparatus out of what is actually a single solid piece instead of using more or less unsatisfactory cements. The advantage of such solid construction is particularly evident in polarimeter tubes and absorption cells—the latter can now be constructed with truly parallel faces and with inside faces optically worked.

The process of joining which the authors have worked out consists in placing the surfaces of glass to be united in good optical contact under pressure, and then raising the temperature to a carefully determined degree. The glass surfaces thus treated become perfectly united, so that the two pieces of glass will not separate along their former interface, and the composite piece acts as if it were a single solid mass, even a crack or a diamond-cut will pass thru the junction without hindrance or deflection. The temperature employed is chosen as high as possible in order to lessen the time required for union of the surfaces, but if distortion of the optically worked surfaces is to be avoided, then the temperature must not be taken too near the limit, which the authors describe as the "annealing point." This point they determine by observing the strains set up in a piece of glass while being heated at a definite rate in an electric-tube furnace; for each kind of glass they find that these internal stresses—which are readily observed by means of polarized light—disappear quite suddenly. At this point, also, the glass becomes appreciably soft, and can be indented by a sharp tool. When similar kinds of glass are used, having similar "annealing points," then the welding of surfaces in optical contact takes place well below this annealing point. Very dissimilar glasses, however, cannot well be joined, since the softer becomes distorted before the harder is hot enough to weld freely.

Women Radio Operators To Aid Uncle Sam

AMERICAN women have never yet been found wanting when it comes to real dyed-in-the-wool service, no matter what that service might be—even to helping in executing the duties of war. The exigencies of war have now claimed several hundreds of the fair daughters of Cleveland, Ohio, where a new radio service school has been inaugurated by Arthur S. Newman, of that city. It has received the unqualified recommendation of Secretary of War Newton D. Baker, who says of it:

"This effort to teach a number of competent young women the art of wireless telegraphy in order that their services may be available to the Government if needed, seems to me a very practical thing to do, and it shows, too, the patriotic impulse of the service and the practical wisdom of choosing a way in which services may really be demanded."

The classes, which meet every Monday evening at 8 in the Cleveland Advertising Club's rooms, represent a real, sincere and highly practical preparedness measure conceived by Mr. Newman, indorsed by Secretary of War Newton D. Baker, and entered into with a zest that assures success both to instructors and students.

The idea back of the instruction is the training of women to take places of men in telegraph and railroad service and in the wireless service on lake vessels, so that the men now holding those jobs may be relieved for the service the country needs. Railroad men, telegraph and wireless operators have been in great demand since the very inception of strife.

The classes are well organized and happily ensconced in rooms where work is conducted in a quiet, systematic manner. The Cleveland Advertising Club has bent every effort to make the pupils comfortable, and supplies every need for efficient work, like tables and blackboards.

There have been over one thousand applicants for instruction and 238 of these have been accepted. Among these are lawyers, teachers, physicians, professional and business women. A very small per cent. has tackled the intricacies of wireless telegraphy—only about forty, in fact. Of course the wireless operation presents more complications which many girls fear to undertake, and, too, there is a great deal more opportunity for real service in telegraphy than in the wireless.

"Except in case of exhaustive war," Mr. Newman stated, "there will be but little employment for women as wireless operators, while railroad work and telegraphy offer an unlimited field. In case of a long-drawn out war, women would doubtless be employed in the wireless service on freighters and passenger lake boats, but the railroads and telegraph companies can make use of efficient women right now."

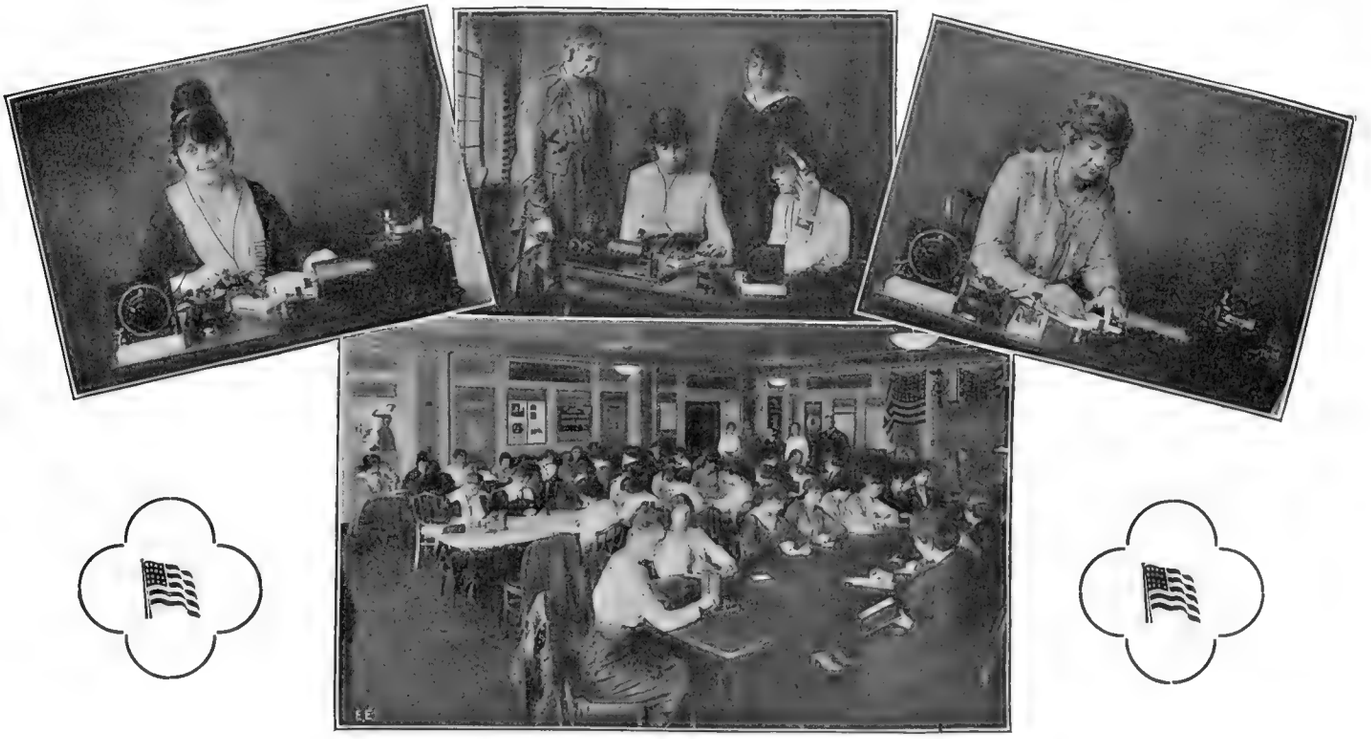
Various railroads have evinced interest in the classes, but the Baltimore & Ohio has assumed a very live and active concern since the very inception of the measure, even sending Charles Seldon of Baltimore, chief telegrapher and head of the maintenance department of the road, to Cleveland to investigate the plan and offer the assistance and co-operation of the road. The company has supplied the classes with books on railroad rules, and has practically guaranteed to place in positions every girl who is turned out from the classes. The railroad has further announced that it is not looking for girls to take the positions in order to cut the pay roll, but will place them on the same salary schedule it uses for its men employees.

Telegraphy, wireless operating, railroad traffic and signaling will be taught during the course. The classes meet in separate rooms. A part of the two-hour period is given to talks, and the rest to practise work.

The directors of the school endeavor to bring speakers each Monday evening, who will fire the patriotism of the students as well as give them practical talks on the subject matter. Scientific demonstrations are also given, and as the work progresses, more complicated and technical programs will be planned.

The girls work at three tables in the telegraph room. Tables are equipt with instruments, and each table has its own instructor. Miss Agness Galagher, who has

(*Continued on page 270*)



Indorsed By the Secretary of War and Engineered By a Progressive Cleveland, Ohio, Man, Mr. Arthur S. Newman, These Sturdy American Girls Are Rapidly Learning the Arts of Radio and Wire Telegraphy, So As To Be Ready When Uncle Sam Needs Them.

DATE OF ISSUE.—*As many of our readers have recently become unduly agitated as to when they could obtain* THE ELECTRICAL EXPERIMENTER, *we wish to state that the newsstands have the journal on sale between the fifteenth and the eighteenth of the month in the eastern part of the United States and about the twentieth of the month west of the Mississippi River. Our subscribers should be in possession of their copies at these dates. Kindly bear in mind, however, that publications are not handled with the same dispatch by the Post Office as a letter. For this reason delays are frequent, therefore kindly be patient and do not send us complaints as to non-arrival of your copy before the twenty-fifth of the month.*

ONE CENT'S WORTH OF ELECTRICITY.

At ten cents per kilowatt hour electricity will operate the following for one cent:

A 16-candlepower Mazda lamp for five hours.

A six-pound flatiron 15 minutes.

A radiant toaster long enough to produce ten slices of toast.

A sewing machine for two hours.

A fan 12 inches in diameter for two hours.

An electric percolator long enough to make three cups of coffee.

A heating pad from two to four hours.

A domestic buffer for one and one-quarter hours.

A chafing dish 12 minutes.

An electric broiler 6 minutes.

An electric griddle 8 minutes.

A radiant grill for 10 minutes.

An electric curling iron once a day for two weeks.

It will operate a luminous 500-watt radiator 12 minutes.

A portable vacuum cleaner 45 minutes.

A sewing machine motor two and one-half hours.

A vibrator (for massage) four hours.

A washing machine for half an hour.

"BUY A LIBERTY BOND" ELECTRIC SIGN BLAZED.

One of the leading New York electric sign producers erected this sign for the Government, free of all cost. They also maintained the sign free of cost to Uncle Sam and paid the "juice" bill. That's what we call real patriotism! Let's have more of 'em. The space is a $20,000 one. The original plan was to erect an exceptionally artistic sign, but the time was too short, so Mr. Woolley, the Director of Publicity at the Treasury Department, suggested the design as used. The phrase, "The Fate of Mankind Lies in Your Hands" is his thought.

There are 3,800 lamps in the sign, and the structure is 50 feet high and 125 feet long.—*Photo courtesy O. J. Gude Co.*

WIRELESS PATROL OF TRANSMISSION LINES.

The Chattanooga Wireless Club, an amateur organization having wireless stations at Chattanooga and Cleveland, Tenn., rendered excellent service to the Tennessee Power Company on three occasions by discovering breaks in the transmission line. The company has used an aluminum line, and when this parts, the arc has made itself heard at the wireless stations.

ELECTRIC VIBRATORS HELP HEAL CANADIAN WOUNDED.

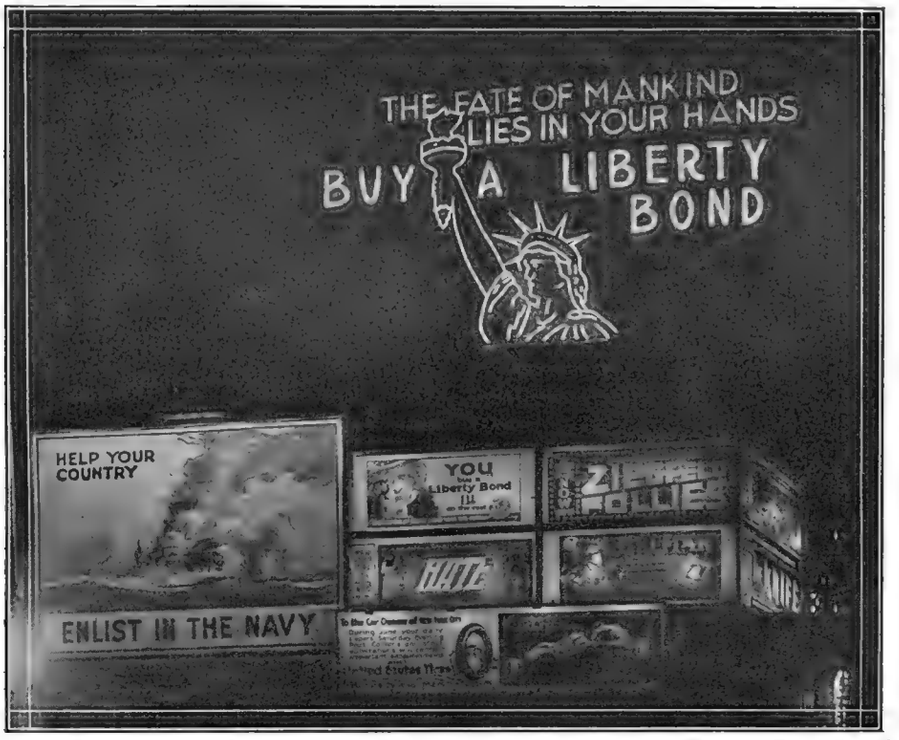
Surgeons in most of the hospitals caring for soldiers have found the electric vibrator extremely helpful in assisting the cure of returned soldiers, suffering from any form of muscular paralysis. The devices hasten by days the cure of bayonet, shrapnel and gun shot wounds, as well as sprains, strains and bruises. Nerves shattered by long hours under fire in the trenches, sudden shell-shock, and the resulting nervous disorders, are all benefited by electric vibratory treatment.

The Electric Vibrator as Well as the Treatment Lamp Have Come Into Their Own for Relieving the Stiffened Muscles and Wounds of Hundreds of Canadian Wounded, the Illustration Showing These Devices in Use.

Under a doctor's instruction the nursing sister can use the vibrator on the patient with equally good results, and as the patient improves he himself can assist his cure. This treatment is said to energize and vitalize, besides purging the blood of toxic poisons—soothing the nerves and giving complete relaxation more restful than sleep.

The illustration shows a special vibrator, as well as a thermolite treatment lamp in actual use in one of the Canadian convalescent homes.

The thermolite, whose healing properties are produced by a combination of light and heat, is highly recommended for nervous complaints.



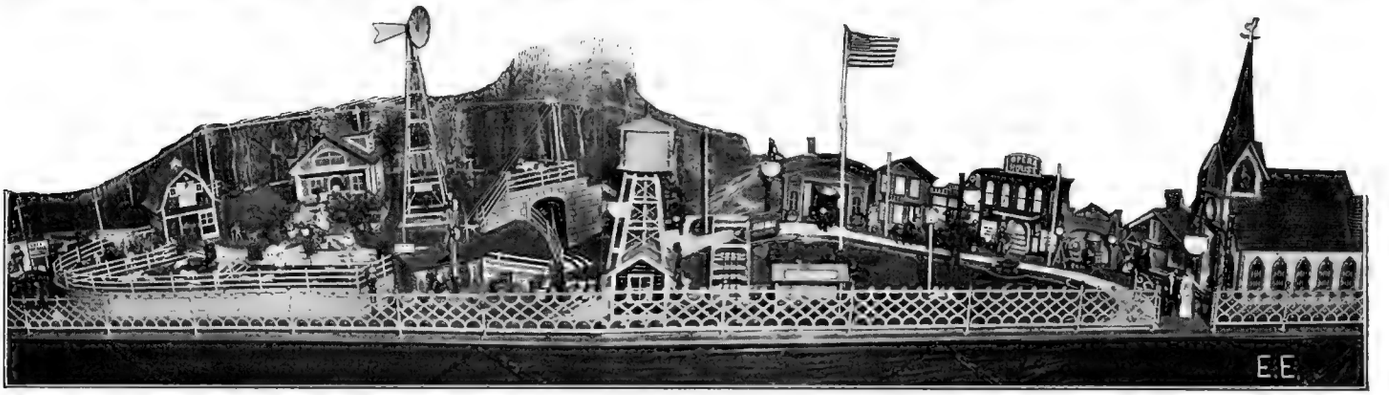
These Electric Signs "Buy a Liberty Bond" and "Enlist in the Navy" Were Erected and Maintained in New York City Free of All Cost to Uncle Sam by a Patriotic Concern in That City.

CITY SELLS LIGHTING POSTS FOR MUNITION USE.

The Street Department, Bronx, N. Y., has arranged for the sale of about 6,000 old lamp-posts used for gas service, and now superseded by an electric street-lighting system, to R. D. Wood & Company, Philadelphia, Pa., at a cost of $1.06 each, with removal by the purchaser. Prior to the country's entrance into the war the borough had been paying about $11 each to have the posts removed by private contractors, bringing a considerable asset where a financial burden was anticipated. It is said that the posts will be utilized in shrapnel manufacture.

An Electrical Miniature Village de Luxe

WE were all kids once, to be sure, but it is doubtful if any of us ever had such a wonderful play-thing as two little Chicago boys, George and Robert, the twin sons of Mr. and Mrs. Robert Hutchison, who have an electric village that might very well typify in miniature the great electrical city of Chicago in which they live. The photograph cannot, of course, show the movement of the miniature railroad train, operated by electricity; nor the speeding third-rail interurban electric car; the whirling windmill pump; the twinkling of the electric stars in the little blue firmament provided; the tolling of the church bell and the music of the organ; the man cranking the automobile at the entrance to the garage, and the flashing of the sign on the opera house. These things the camera must show as tho they moved not; but when the village is in operation they all do move and, in addition, the pretty little electric fountain throws its spray nearly a foot into the air, the electric street lamps glow, the store, residence and church windows shed a pretty light, and the safety gate at the railroad crossing, just where the big engine is standing in the photograph, falls and rises with precision on the approach of the train and when it has past.



How Would You Like to Be the Boy Who Owns This Wonderful Electric Village—Where the Trains Whiz by the Crossings, the Windmill Turns, the Church Chimes Ring, and Even the Opera-house Electric Sign Flashes On and Off? Two Chicago Boys Are the Happy Owners and We'll Bet Dollars to Doughnuts They Will Grow Up to Be Future Edisons. Such a Display Is Nothing If Not Highly Educating and Inspiring.

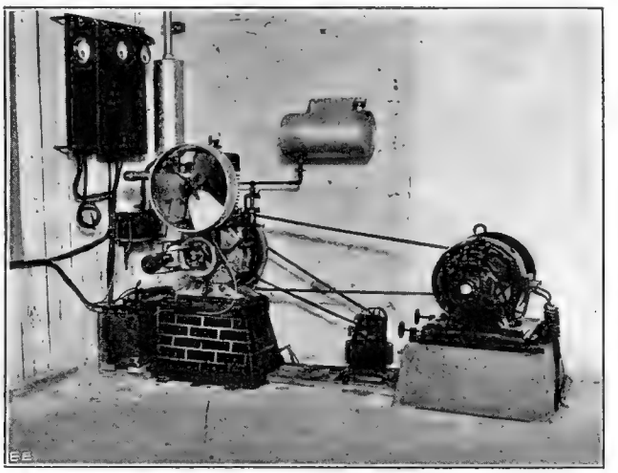
All of these things are arranged with beautiful mechanical perfection of finish and detail. The base is fifteen feet long and six feet wide. The motive power for everything is electrical, there being nine separate small electric motors in different parts of the foundation of the electric village. There are no less than 42 miniature electric lamps, counting headlights on the trains and other small lights.

With the aid of an able assistant whose artistic work with the brush appears in the decorative part of the work, Mr. Hutchison, who made nearly every detail himself, has worked out these things and many more, with a careful regard for relative sizes; thus, the farmer standing in the barnyard, and the horse and other live stock nearby, are relatively of about correct proportions; so are the other people on the street and on the porch of the house, and so are the buildings and the implements and accessories which go to make up the completeness of social and commercial activity in this model village.

The village main street begins just to the right of the residence, and along it will be seen the house, the garage, the opera house, the stores and the church. The residence is on a grassy knoll with lawn and path neatly laid out, and the railroad line finds it necessary to pass thru a long tunnel underneath this part of the scene. The street railway, on the other hand, makes a loop over a pretty rustic bridge and around the park with the little pond and the ducks at the right-hand end in the foreground, passing back to another loop at the left hand and returning. An interesting feature of this street railroad is the automatic switches connecting the main track with the loop at each end and operated by the flange of the rear wheels of the car as it passes over them, so that the next time the car approaches the loop it will pass round it in the opposite direction, varying the effect.

The electric fountain used to be supplied from the water tower, the pump feeding the latter; but this has been superseded by a direct feed from the pump to the fountain, a metal diafram and air chamber equalizing the pressure.

So particular has Mr. Hutchison been about the construction of his electrical features, that there are certain lamps in this installation which were made especially for him. These little incandescent bulbs have flat sides like very short bung-hole lamps of miniature type, and were made to accommodate themselves to the little electric lanterns which were originally purchased as oil lamps and have been made over by Mr. Hutchison. All motors have been rewound to accommodate themselves to the voltages derivable by the use of a 150-watt step-down toy transformer and the alternating current lighting circuit. The smaller illustration herewith shows the neat 400-watt electric plant, comprising a dynamo driven by a gasoline engine. A suitable switchboard is installed so that service may be taken from the electric light company's mains or from the isolated plant here pictured.



The Complete Independent 400-Watt Electric Generating Plant Which Is Available for Supplying the Miniature City Shown Above with the Necessary Current.

A very neat asbestos board switchboard on the wall near by has switches for all the principal divisions of the exhibit, including the street lighting, the street car, the railroad train, fountain, windmill, graphophone, church chimes, sign flasher, star flasher, store lights, automobile, crossing gates, etc.

It is quite interesting to see the two little boys manipulate these switches with the utmost quickness and precision to exhibit the various effects of which they are so fond.

Mr. Hutchison sets up this electric village in the basement of his residence each Christmas time, and for the last five years it has been growing to its present proportions.

LIABILITY TO TRESPASSERS ON POLES.

An employee of a telephone company went on the pole of a power company in the absence of any contract or agreement giving the employee or the telephone company the right to do so. He was injured by an electric shock received thru a defect in a transformer. In an action against the power company it was held that both the telephone company and its employee were trespassers on the power company's pole, and the power company was not liable for the injury. The establisht principle in the law of negligence, that there is no liability to trespassers except for injuries wilfully or wantonly inflicted, is applicable to electric companies and electric appliances.

A wireless plant fully equipt and capable of sending messages 5,000 miles, was discovered by government Secret Service officials near the base of Mount Hood in the Cascade Mountains of Oregon recently. Evidently the proposed raid had become known, the plant being abandoned.

BEAUTIFUL ILLUMINATION OF CAPITOL AT WASHINGTON.

Against the sombre shadows of night, at this critical moment in our history, the inspiring white dome of our Capitol at Washington, high above the Federal City, stands resplendent in rays of shining light, a radiant monument to freedom and democracy. The plans for illuminating the Capitol dome were perfected for the recent inauguration of President Wilson, and the spectacular results were so satisfactory that the system was made permanent.

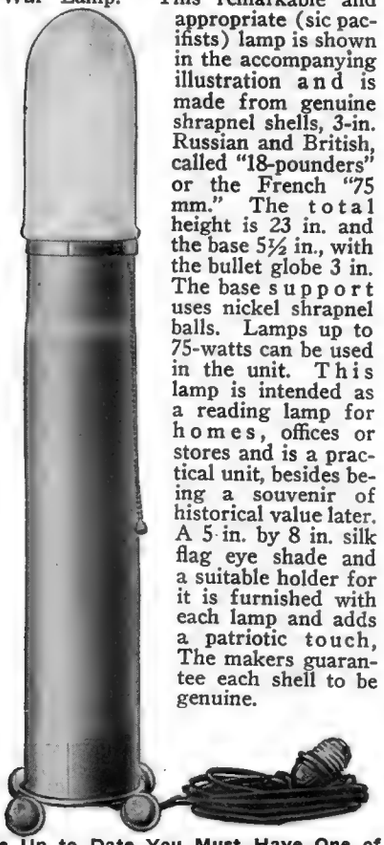
Flood lighting was the method used to illuminate the great dome, which is 135 feet in diameter at the base, 218 feet high above the roof, and is surmounted by a bronze statue of Freedom. Eighty-four flood projectors, each equipt with a 400-watt flood lighting lamp, were used. These projectors were placed in four banks, about 200 feet from the dome, on the corners of the House and Senate wings. By placing the projectors in these positions, it was found possible to throw light from different directions on the 36 columns at the base (representing the 36 states in the Union at the time it was designed), and thus eliminate objectionable shadows. Some shadows are desirable to bring out the architectural beauty, but if the shadows are too pronounced they become objectionable.

The Capitol at Washington, D. C., at Night with Its New Electric Flood Lighting—a Triumph in Illumination Engineering.

The building proper was also lighted to a low intensity, to form a setting for the dome and to relieve the contrast between a very light dome and a dark building. The building is about 750 feet long and 250 feet wide. The central portion, or main building, is of sandstone painted white, and the House and Senate wings at the ends are of white marble. Surrounding the building on three sides is a wide concourse bounded by a parapet. Thirty-four flood lighting projectors, each equipt with a 400-watt flood lighting lamp, were mounted on ornamental posts and placed on this parapet. The poles were originally designed to take large opal globes. These globes were removed and blocks of wood were placed in the fittings, to which the projectors were bolted. Thus the projectors were inconspicuous and did not detract from the natural architectural features around the building. *Photo. G. E. Co.*

A REAL "WAR" LAMP MADE FROM SHELLS.

An Ohio concern is now offering a special lighting unit which is known as the "War Lamp." This remarkable and appropriate (sic pacifists) lamp is shown in the accompanying illustration and is made from genuine shrapnel shells, 3-in. Russian and British, called "18-pounders" or the French "75 mm." The total height is 23 in. and the base 5½ in., with the bullet globe 3 in. The base support uses nickel shrapnel balls. Lamps up to 75-watts can be used in the unit. This lamp is intended as a reading lamp for homes, offices or stores and is a practical unit, besides being a souvenir of historical value later. A 5 in. by 8 in. silk flag eye shade and a suitable holder for it is furnished with each lamp and adds a patriotic touch, The makers guarantee each shell to be genuine.



To Be Up to Date You Must Have One of These Electric Table Lamps Made from Genuine 75 mm. Shells.

ELECTRIC PROGRESS IN JAPAN.

Japan is taking to electricity like a duck to water. The Lake Inawashiro plant now includes six 10,000 h.p. turbines, and transmits power at a pressure of 115,000 volts over 140 miles of transmission lines in Tokio. This is one of the big hydro-electric schemes which Japan has now put in service. At the end of 1914 there was a total of 1,940 stations supplying electricity, 390 of these being central stations, 24 railway plant, 47 combined railway and central station plant, 1,366 isolated plants, and the remainder official installations. The water-power stations number 695, steam 788 and gas-driven stations 547. The total capacity of these stations is 608,544 kw., of which 341,809 kw. are central stations, 140,000 isolated plants. The water-power equipment totalled 366,243 kw., steam 217,967 kw., and gas stations 24,344 kw. There were 21,909 miles of aerial and 751 miles of underground transmission lines.

METAL HEATING PAD.

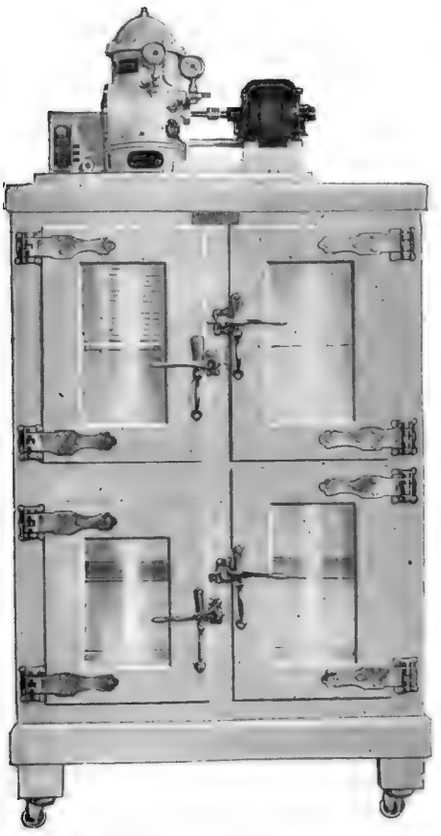
A western manufacturer has placed on the market, after thoro testing, a metal heating pad. This hot-pad consists of a heating element encased in a nickeled steel jacket made up of hinged units permitting the bending of the inner heating element. The flexibility is sufficient for the requirements demanded of a hot-pad as the illustration shows; it may even be wrapt around a limb.

It operates from any lamp-socket, consumes 40 watts and its heat is easily regulated, even in the dark or under the bed-cover, by a small lever. Any temperature from 100 to 200 degrees Fahrenheit is easily attained and automatically maintained by thermostat; it cannot become overheated, as current is shut off automatically when certain temperature is reached. Under average conditions, it may be operated at least five hours for less than one cent's worth of current. It is provided with soft, washable and removable eider-down cover and encased in "parchmyn" envelop. It comes complete with cord and connection plug, ready for use.

The Electric Metal Heating Pad Here Illustrated Is Excellent for That Stiff Neck, Ear-ache, or Neuralgia. It Connects with Any Lamp Socket.

LET THE ELECTRIC REFRIGERATOR KEEP YOUR FOOD.

The electric refrigerator illustrated comprises a motor-driven ice-machine adopted to any standard refrigerator, the ice machine itself occupying what would ordinarily be the ice-box. Here we have the cooling coils, partly immersed in a brine tank containing receptacles in which small blocks of pure ice are formed for table use. This electric refrigerator is claimed to be entirely safe. Explosions in large refrigerating plants are due to the use of ammonia gas under pressure. To avoid possible danger from this source in the household refrigerator, ethyl chlorid at low pressure has been substituted for ammonia.



Using Ethyl-Chlorid as the Refrigerant, This Electrically Operated Refrigerator Automatically Keeps the Food Compartments at Frigid Temperature. Besides, It Freezes Ice Cubes for Table and Kitchen Use.

This type of electric refrigerator is automatic. It is regulated to maintain a constant temperature, the machine starting and stopping automatically, by means of an ingenious thermostatic control. All valves are locked; the consumer is not called upon to make any adjustment, and the machine will run from one to three years without adjustment.

Artificial refrigeration by such a machine is said to be much cheaper than ice. About two and one-half kilowatt hours of current are required for one hundred pounds of ice-effect in the course of one day. At the eight-cent rate for current, this makes the cost of refrigeration twenty cents for the ice-effect of one hundred pounds, as contrasted with real ice at forty cents a hundred. In suburban and country districts the contrast is still more marked for the price of ice there more frequently runs up to sixty and seventy cents a hundred, and in addition the ordinary ice supply is usually irregular and inadequate.

Automatic control cuts down the amount of electricity used, for when the set temperature is reached the motor is automatically cut off. Thus the machine consumes current only when actually in operation, and this is but a small proportion of the twenty-four hours. The entire machine can be operated from an ordinary lamp-socket, this being another indication of the small amount of power required.

With an electric ice machine, the purity of the table-ice can be absolutely guaranteed, each family using whichever distilled water it prefers for this purpose. Table ice is frozen in about two hours' time. Furthermore, with artificial cooling substituted for melting ice, the refrigerator can be kept strictly clean with little effort, thus preventing contamination of food.

The household refrigerator comes in three sizes; the smallest is rated to give the cooling effect of one hundred and fifty pounds of ice; the second size, three hundred pounds; and the largest, six hundred pounds.

The machine is regulated to preserve certain temperatures thruout the refrigerator. In the upper left-hand compartment, where table-ice is made, the temperature is twenty-four degrees Fahrenheit. The section below it is kept at thirty-eight degrees, the lower right-hand compartment at forty-two degrees, and the upper right hand at forty-six degrees. These variations provide for proper circulation of air within the refrigerator, thus keeping it dry and sweet. They are also desirable, as foods require different temperatures for best results in their preservation. Thus, milk, butter and eggs would be placed in the lower left-hand compartment; cooked foods and meats in the lower right-hand chamber; and fruits and vegetables, requiring a less degree of cold, in the upper right-hand chamber.

The refrigerant, ethyl-chlorid, is a neutral gas which in the manner employed does not change or deteriorate with use, neither does it act on the metals of which the machine is constructed. The process employed is known as the compression system; the gas is expanded from a liquid state at a relatively high pressure to a gaseous state at a lower pressure, corresponding to the temperature required. This gas is withdrawn from the cooling coils and discharged into the condensing chamber by means of a specially designed rotary compressor, where, by the combined action of pressure and cooling by water passing thru the condenser coil, the latent heat of vaporization is removed, and the gas condensed to liquid again, ready once more for the refrigerating cycle. Water consumption is at the rate of about fifteen gallons per hour while the machine is running, the flow being shut off when the machine is stopt.

Mine gas is detected with a portable electric outfit which miners carry.

FLASHLIGHTS AS CHEAP AS MATCHES.

It costs no more to operate an electric flashlight than to use matches for the same purpose, according to figures compiled recently. Each modern tungsten battery (for flashlight use) is guaranteed to burn for a certain number of hours, and, using this guarantee as a basis, it is found that the average cost of operating such a flashlight is one cent for 600 flashes, of a second each, or for 60 flashes of 10 seconds each.

Now, the average one-cent box of matches contains just 60 matches. Each of these will burn for 15 seconds, but when allowance is made for some blowing out and others being used for a second or two only, it is estimated that the average match does not burn longer than 10 seconds. At this figure the cost would be the same as that of using a flashlight.

Some of the most popular styles of flashlights, however, cost a good deal less than this to operate. Take for instance, the tubular pocket flashlight, in which the battery gives 1,200 flashes of a second each for one cent. This size battery costs one-half as much to use as would safety matches.

AN ELECTRIC TABLE LAMP THAT SPEAKS.

The combination phonograph and electric lamp shown in the accompanying illustration has been developed by a New York inventor. The phonograph is concealed in the base of the lamp, which is so designed that it will accommodate any size records up to the 12-in. disk. When the phonograph is to be played the hood is raised, the disk inserted and the power turned on.

The disk is revolved by a small motor in the same circuit as the electric light, but controlled by a separate switch. This arrangement makes it possible to play the instrument when the lamp is not in use. Instead of using a horn as with some "talking" machines, the sound is diffused thru the stem of the lamp, which, it is claimed, considerably softens the tone. The "phonolite," as this combination set is called, is especially applicable where there is a limited amount of room as in small apartments.

Behold! the Electric Table Lamp That Speaks and Sings—Thanks to a Phonograph Cleverly Concealed in the Base and Driven by a Miniature Electric Motor.

ELECTRICAL CITY GUIDE TELLS WHERE YOU'RE AT.

By D. Wyman.

A novel device, the *Electric Directory*, has been installed by several prominent New York City Hotels and will soon be seen all over the United States.

How Do I Get to 125 Street and Seventh Avenue? That and Hundreds of Similar Ones Are Now Answered by the Electric Street Guide, Here Shown Installed in the Hotel Martha Washington, New York City.

The apparatus serves the dual purpose of an accurate street guide and attractive sign board. It is of pleasing appearance, about sixteen square feet in size and has an all-glass and mirror front. In its center is a large map of New York City with a number of interchangeable advertising spaces arranged alongside of it. Below the map are two boards, each mounted with thirty numbered push buttons. In a pocket between the push button boards is an *Index Book*, wherein every point shown on the map is alphabetically listed, with a number placed opposite each of them. All a person has to do to operate the guide is to press the button bearing the number of the place sought; railroad station, part of street or avenue, etc., whereupon a bright light appears on the map giving the desired location, while a red light indicates the hotel as the starting point. The pressure of any button automatically flashes up all the advertisements, which together with the map are, however, visible and readable even when not illuminated.

Fifty 4-volt lamps are evenly distributed behind the advertising spaces. The current is supplied by a special type of storage battery. The pressure of any button closes the circuit to one map light and to the starting point indicator, automatically operating a relay which closes the second circuit for the fifty advertising lights.

TEACHING WAR AT COLUMBIA.

Columbia University's enrolment in the special war courses which opened some time ago has exceeded all expectations. The work is in charge of Prof. James C. Egbert, director of the department of extension teaching. Prof. Egbert has decided to permit students to enter the classes for several more weeks.

The courses include training in trench construction, camp sanitation, army regulations, radio telegraphy and engineering training such as is needed by army engineers and for similar courses.

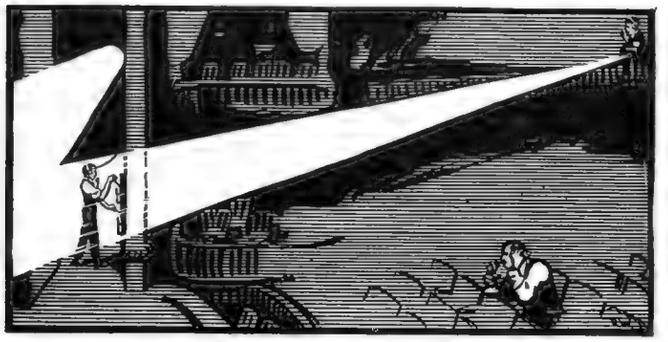
Other courses are offered for governmental training, and hosts of classes are open for special training for women who desire to be of service to the Government during the war.

HOW TELEPHONE AIDS STAGE LIGHTING DESIGN.

The great motion pictures of the day are practically all directed by means of the telephone, but the telephone is used not only for directing motion picture scenes, but also as a modern aid in securing desired lighting effects in connection with the staging of scenes in a theater catering to legitimate drama.

An expert in lighting effects equipt with an operator's set occupies a seat in the audience and transmits instructions to the stage electrician also equipt with an operator's set, who is stationed at the electric light switchboard, which is located on one side of the stage. By using the telephone, the most perfect lighting arrangements can be obtained and proper adjustments made at the instant under expert direction without the noise of bells, buzzers or other signals, as the telephone line is in constant use thruout the performance.

The stage electrician is so located that it is impossible for him to see the lighting effect as it is seen by the audience. The telephone has again solved a problem and has accomplisht the desired results with success.—T. R.



The Telephone Has Found Another Role in Helping the Experts to Design Theatrical Illumination Effects.

AT LAST A VERTICAL COMPASS.

Navigators on the Sea or in the Air can now ascertain their direction from a compass whose dial is *vertical*. This is especially convenient because it makes possible the reading of a compass set on a level with the eyes and does away with the necessity of bending forward and over the compass. At the same time the vertical compass on aeroplanes can be mounted a greater distance from the disturbing elements, such as control cables, etc.

This new compass was invented by Captain F. O. Creagh-Osborne, Superintendent of Compasses for the British Admiralty. It is now manufactured for the United States Air Service by Elmer A. Sperry, member of the Naval Consulting Board, and inventor of the gyro-compass now used in American and other first-class navies thruout the world.

This new instrument is a magnetic compass, having the card mounted in a liquid in order to minimize oscillation and to help support it. The *compass card* really is a narrow strip of metal mounted on the float. The points of the compass are indicated on the card with a *radium compound* so they will be visible at night. The bowl of the compass is like a metal sphere having a circular window on its surface.

•Always, for Centuries, Mariners Have Had to Look Down on a Compass. Now They May Look Straight Ahead, Thanks to the "Sperry" Vertical Compass.

This bowl is mounted so that the vibrations are not transferred by the frame to the card. Gimbal rings are entirely dispensed with and, at the same time, a generous heeling angle is obtained. Neither reflecting nor refracting devices are necessary, the compass being read directly. Compensating magnets are provided in the small container attached separately to the frame.

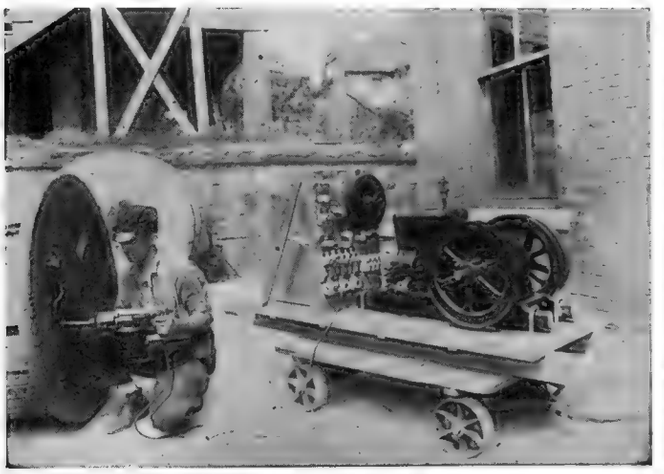
ELECTRIC AUTOS IN MADRID.

It is considered probable that there will shortly be a good opportunity for pushing the sale of electric vehicles in Madrid, as the cobble pavements of the city must be replaced by asphalt or other similar surface within two years.

The ordinary animal-drawn carts and heavy wagons are injurious to asphalt pavements, and it should not be difficult to get a footing for the smooth-running and reliable electrically-propelled vehicle.

UNIQUE PORTABLE ELECTRIC PLANT.

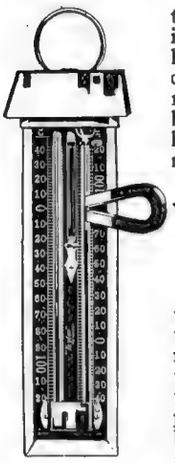
The accompanying photograph shows a portable electric generating outfit which has been manufactured especially for the use of the American Telephone and Telegraph Company, in building the Jacksonville-Key West toll line along the concrete causeways of the Florida East Coast Railway. The set consists of a 1½ h.p. gasoline engine, belted to a 120 volt 30 ampere generator. The wiring on the power board admits of attaching three leads which are used for the electric drills and electric hammers, one of the latter being shown in the position in which it will be used. The weight of the entire outfit is not great, four men being able to handle it easily. —*Photo courtesy Western Electric Co.*



Extremely Compact and Efficient Portable Engine and Dynamo Set for Supplying Current to Electric Hammers and Drills, One of Which is Here Shown in Use.

MAGNET RESET FOR MAXIMUM AND MINIMUM REGISTERING THERMOMETER.

The thermometer shown in the illustration below is *set* by drawing the bottom of the index in each side of the tube down to the mercury column, with the magnet.



As the temperature fluctuates the mercury will rise in one side or the other, leaving the index in either case to show when the next reading is taken what has been the highest degree of heat or cold since the thermometer was last *set*.

WIRELESS FOR TRANSMISSION LINE SERVICE.

A new and important use has been developed for wireless telegraphy in connection with long-distance transmission lines of electric light and power companies. For communication between stations over large systems of this character, a private telephone service usually is installed along the route, with lines strung on the transmission poles or towers, making them liable to all the troubles to which the power leads are subjected.

The wireless has now stept in to eliminate the many inconveniences and interruptions of communication over metallic circuits with absolute and reliable service under all conditions of operation. The radio installation seems destined to be placed to this new use with increasing range of accomplishments and unquestioned possibilities, both in service and maintenance features, becoming a highly essential factor for extensive power transmission systems, where continuous and positive service always is necessary.

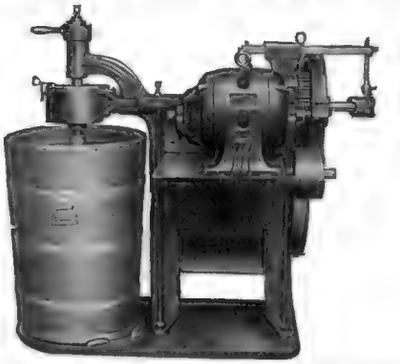
As a result of many practical experiments, the Southern Sierras Power Company of California is rapidly adopting wireless telegraphy transmission and reception between its important power plants and substations, readily appreciating the value and dependability of radio-communication at all times. The company's system extends from Bishop, Cal., to the Imperial Valley district, a distance of about 500 miles, consisting for the most part of a double three-phase high-voltage circuit on steel towers. The stations in the Bishop Creek section, on the north are situated on a rugged and mountainous country, a territory which is frequented by sudden and exceptionally severe storms and floods and extreme weather conditions.

Radio transmitting and receiving sets have been installed to provide communication over this district, as well as at other important plants on the main transmission system leading into San Bernardino. Plans are being perfected to provide all other primary stations with wireless equipment, effecting a complete chain for radio-communication thruout the company's territory. In this, the equipment installed at the different plants will be arranged for a particular type of service, in some instances allowing for a communicating radius of 500 miles or more, and in others for connection with the next sub-station along the route only; dependent upon the character and province of the station. The service, when entirely installed and perfected, will be used both for regular and emergency purposes.

It is interesting to note that the station operators have welcomed this change from the telephone and telegraph to wireless; and, adept in the use of the key thru the private telegraph system which the company has employed superimposed upon the telephone lines of the system, the new installation has not brought any particular departure in the general workings of the station organizations. Moreover, the company has been active in advancing the knowledge of its operators in wireless and the wireless code, furnishing equipment, data and instructions to make them fully proficient in this new phase of science.—L. R. W. Allison.

ICE CREAM BY ELECTRICITY.

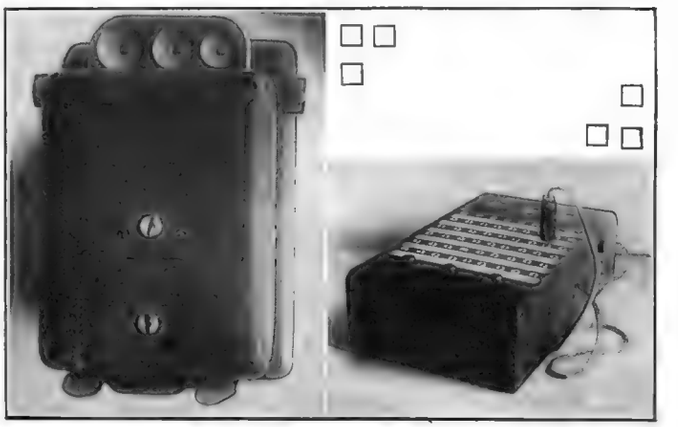
Did you ever grind an ice-cream freezer on a sultry July day, and—eventually lose about 4 pounds avoirdupois, along with your appetite for the great American delicacy. That's the usual case—but our friend, the electrical engineer, has perfected an electric motor drive for turning the ice-cream freezer which is warranted not to develop a "glass" arm when the cream is about half frozen. The cost of one hour's operation for this welcome servant is only a fraction of a cent for the family size outfit, and the initial cost is soon repaid. It is furnished in both large and small sizes.



Ice Cream at Any Time, When You Have the Motor-Driven Freezer at Hand. It Saves Its Cost in a Very Short Time.

COLLECTING TELEPHONE TOLLS BY MACHINE.

A device used as an accessory to telephone systems and which, it is claimed, simplifies the collection of telephone tolls among tenants in apartment houses, hotels or other buildings has been developed by a New York concern. The device may be placed on the switchboard ledge and connected with a coin collector in every apartment. The machine enables the operator to determine whether a coin is deposited in any particular machine. Such notification will correspond with the different denominations of the coins used. The operator can also cause any number of deposited coins to be delivered to a customer, either for the purpose of making change or for returning the equivalent of any deposited coin or coins. If a tenant does not have the necessary money with which to pay for a call, the operator can cause a check or checks to be issued to the tenant, who in turn deposits them in the machine. The value indicated on these checks is redeemed by the customer when the regular monthly or weekly collections are made.



A New Device Intended to Facilitate the Collection of Telephone Tolls in Apartment Houses and Hotels. It Enables the Operator to Check Coins Deposited and Also to "Make Change."

Even the Chinaman has found electricity a cheap and obedient servant. Thousands of electric irons and cooking utensils are used in China.

Unique Electrical Apparatus Reads the Mind

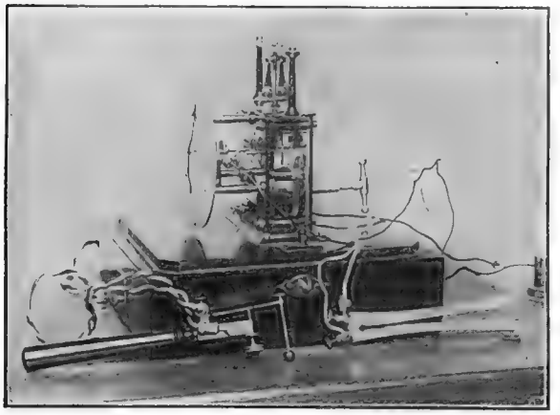
The accompanying illustrations show two extremely interesting electrical apparatus of French design, and which are of particular moment at this time, when we hear so much about industrial and various other kinds of psychological research. The larger illustration shows a precise electrical instrument, comprising an electro-magnetic solenoid which operates a shutter. When this shutter descends, as in the present illustration, it exposes for a short space of time, several words, or in some cases several sentences, the time of all such exposures being governed accordingly. The person taking the memory test with this apparatus sits in front of the table and the operator simply presses a button which causes the electric solenoid to drop the shutter of the apparatus quickly. By means of a stop-watch the time during which the shutter is dropt is accurately taken note of by the expert making the test, which time may be a few seconds or more, depending upon the length of the sentences or phrases, and by carefully grading the make-up of the words and sentences flashed before the eyes of the person undergoing the test and also by making a series of careful observations of the various time periods required for the person to more or less accurately memorize th se captions, an accurate criterion of the subject under test is obtainable.

Photos from Jacques Boyer

How Many Words Out of 25 In a Group of Sentences Can You Remember If They Are Flashed Before You for a Fifth of a Minute? With This Electric Shutter Device and a Stop Watch the Expert Will Know Exactly What Kind of a Memory You Have.

The smaller photograph shows a D'Arsonval chronoscope or electrical time mechanism designed for certain applications in psychological research. This apparatus can be used by the average person with very little training. Its use in one particular instance is for measuring the exact time, in thousands of a second, required for auditory reaction, or in other words—the time required for the nerve waves to pass from the ears and to signal the brain that a sound has been received by them. The special, double contact electrode used by the expert making the test is provided ith a small tapper, so designed that when this is used to strike a bell, that its movement will cause the electrical circuit to be opened.

Connected with the clock-work of the electrical chronoscope is a second two-contact electrode shown at the right and which is held in the hand of the person under test. The procedure is as follows: The expert strikes the bell with his special electrode, and the instant the gong sounds, the electrical circuit thru the chronoscope is opened, permitting the clock-work to rotate the hand over the dial, which is spaced off in small fractions of a second. As soon as the subject hears the sound (which is not, it should be noted, at the exact instant when the sound strikes the membrane or drum of the ear, but an appreciable and measurable time afterward) he at once presses the contacts of the electrode in his hand, and this actuates an electro-magnet on the chronoscope, causing it to stop. It is thus a simple matter to at once read off the fraction of a second required for auditory reaction to take place.



A Gong Is Struck with the Electric Hammer at the Left; When You Hear the Sound You Compress the Hand Switch (at Right) and the Electric Chronograph Registers In 1-1000ths of a Second the Time Required for Auditory Response.

A NEW PORTABLE PYROMETER.

By Thomas W. Benson.

Possibly the first form of portable pyrometer or means for measuring radiant heat was the human eye. And stranger still to relate is the fact that some of the *Old-timers* can heat-treat steel more accurately by eye than some of the younger experts who use the various forms of pyrometers.

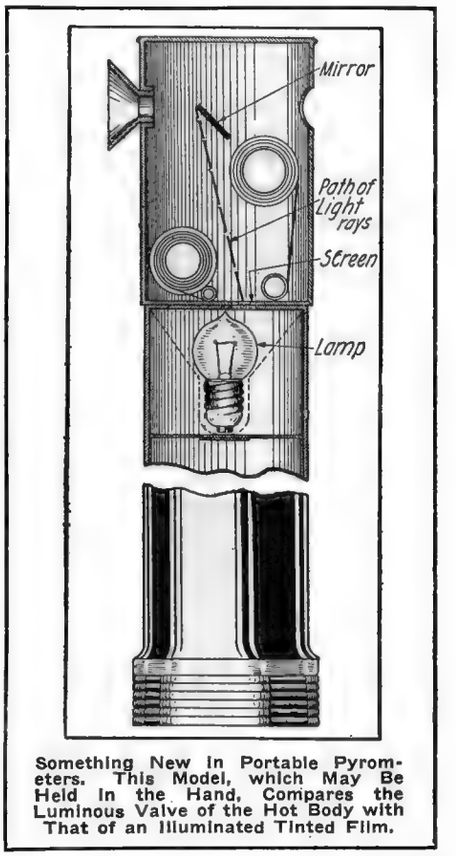
This is not difficult to understand when it is considered that pyrometers using a fixt thermo-couple do not measure the temperature of the piece under treatment but merely the temperature of the furnace itself. That a difference exists in the temperature of the two requires no proof.

The portable form of pyrometer solved this by measuring directly the temperature of the body itself by measuring the brilliancy or amount of light given off. This method takes advantage of the fact that the temperature of steel varies directly as its luminosity after it begins to glow.

The illustration shows the constructional details of a unique portable pyrometer recently brought out. This device is about the size of a large tubular flashlight, being but 8½ inches long. It can be easily carried in the pocket, is sturdy, accurate and not apt to get out of adjustment.

As will be observed the case contains at the lower end a flashlight battery that supplies current to the small incandescent lamp. Above the lamp is placed ar opaque diafram in which is mounted a diffusing screen. By means of small rolls and knobs mounted on the outside of the instrument it is possible to cause a tinted film to pass before the diffusing screen. The film is tinted in the varying shades of color assumed by a heated body. The different shades are carefully calibrated with relation to the corresponding temperatures.

At the left is seen the conical eye-piece through which the operator views the hot body under observation. A small mirror is arranged to cover one-half of the field of vision as shown. This mirror reflects the light that passes thru the tinted film from the lamp.



Something New In Portable Pyrometers. This Model, which May Be Held In the Hand, Compares the Luminous Valve of the Hot Body with That of an Illuminated Tinted Film.

In use the rolls are turned until both halves of the field correspond exactly in shade, then by referring to the dial it is possible to determine accurately the temperature. It is possible to build the device in practically any range, but the more common ranges are 1000-1800 degrees Fahrenheit and 1800-2300 degrees Fahrenheit.

NEW YORK HERALD WIRELESS STATION AGAIN IN COMMISSION.

The wireless station of the New York *Herald* was formally returned to commission on February twenty-eighth in its new quarters atop the United States barge office in New York. Mr. John Bottomley, vice-president, secretary and treasurer of the Marconi Wireless Telegraph Company of America, New York, was present at the opening ceremonies. This station was placed under censorship last October.

The Radio Bomb

By C. M. ADAMS

"YOU'VE been wantin' proof. There it is!" With a gasp of astonishment the group about the big stove in Preston's store leaned forward with a jerk, necks craned, mouths and eyes wide, staring in wonder at the object old Tom Waldon had drawn from beneath his big sheepskin coat.

Cylindrical in shape, it was made of heavy steel, measuring about two feet in length by four inches in diameter, and painted a brilliant red, save at one end where the figure "6" was stenciled in black.

"What does that prove?" Dick Preston demanded, from his perch on a cracker barrel.

"Prove?" Waldon repeated, glaring up at the boy who questioned him. "Just what I've been tellin' you — that he's a 'spy' and he'll blow us all up if we don't stop him! Why, me and my hoss would've been blowed to pieces this mornin' if it hadn't been wet from layin' in the snow so long!"

"What is it?" Pete Bailey asked in an awed whisper.

"A bomb!"

With a clatter of upsetting chairs the terror-stricken group fled precipitately to the opposite end of the store.

"Don't get scared!" Dick laughed, slipping down from his barrel and taking the tube from the old man. "Look!"

With a twist of the threaded cap he removed one end of the tube and poured out in his free hand a dirty brown wet powder.

"It's gunpowder!" Waldon exulted.

"Powder, nothing; it's sand and ashes and dirt!" Dick scoffed. "Watch!"

He jerked open the door of the glowing stove and threw in a generous handful of the material. On the red-hot coals it lay in an inert mass, while one by one the group tiptoed cautiously back to see and regain courage.

"Course it won't burn when it's wet," old Tom defended. "That's why it wouldn't go off this mornin'. It was layin' right in the middle o' the road at the end o' my lane and my hoss almost stept on it. So I gets out and picks it up after I'd seed it was wet."

"Suppose it was gunpowder. What does that prove anyhow?" Dick demanded, resuming his seat on the cracker barrel.

"He put it there!" the old man declared. "Did you see him?"

". . . Straight as an Arrow the Uncanny Thing Came, Showing Momentarily the Glimpse of a Humming Propeller. . . . A Huge Column of Spray and Ice Spouted Skyward From the Jam, and—Where Had Been the Towering Ice Barrier, the People of Pine Flat Saw the River—Yellow, Swift and Turbulent, Running Free and Clear Thru the Gap and Down Past the Hamlet."

"Who else would?" Waldon parried. "Who's been prowlin' around here all hours o' the day and night? Who's been livin' in a cabin on Pine Mountain by himself all winter and not sayin' what he's up there for? Couldn't he shoot up the whole valley with a cannon up there?"

"Them boxes and crates and barrels and things he had me haul up, was mighty heavy," Tom Sullivan affirmed.

"Yes, and what's that thing he's been carryin' around that pretends to be a surveyin' instrument?" Pete Bailey demanded.

"All that don't prove a thing!" Dick retorted angrily. "Just because he doesn't choose to tell you what he's here for, and everything about his business, you think he's a spy. Why don't you be reasonable?"

"I am reasonable," old Tom grinned maliciously. "I hain't takin' no chances. I sent down to Squire Jefferson's this mornin' for a search warrant and when it gets here, I as constable, will go to that cabin and see just what he's doing there and find out if he can't give some reason for actin' the way he does!"

"That's the stuff. Good for you, Tom!" a half dozen endorsed.

"Yes sir, I think it was time we was a doin' somethin' besides sittin' around here talkin' and wonderin' and lettin' him have a chance to blow us into next week!" the old man continued importantly, opening his coat so that the nickel-plated star showed plainly. "This here bomb," and he tapt the tube in his lap, "sort o' set me to thinkin' and I'm goin' up the first thing in the mornin' if that search warrant comes up on the mail this afternoon."

"You're doin' just right, Tom!" Pete Bailey declared. "I was just wonderin' if you was goin' to let him run loose around here, while you're constable."

"You bet I won't!" that official boasted.

But Dick Preston did not endorse old Tom Waldon's new decision. For a moment he sat on his cracker barrel, staring in surprise at the old constable and the group about the stove which was so loud in its support of his new plan of dealing with the mysterious and undesirable stranger.

And then without a word he slipt to the floor and past out into the house which adjoined the store and mounted the stairs to the room which he occupied under the eaves.

A worried frown puckered his brow as he seated himself at a table covered with a bright new set of wireless telegraph instruments, and his frown deepened as he adjusted the detector and inductances.

"Suspicious old fool!" he growled as he slipt on the head receivers. "I hope we can beat him!"

"H D, H D, H D, D P," the white spark in the gap crackled in clean-cut Continental as he tapt the key.

Again the call repeated before he threw over the aerial switch.

Then, "O K, D P, H D," sounded the clear reply in his receivers.

"News to report. Coming up," the spark snapt.

"O K," the reply buzzed.

Slipping receivers from his head Dick drew on mackinaw, mittens and cap, as he went rapidly down the stairs, and paused on the back porch to adjust a capable looking pair of snowshoes.

Then off up the slope which rose abruptly at the rear of the building he swung, laying a course eastward to where Pine Mountain reared its low broad bulk against the skyline. For a half hour he climbed, leaving behind the hamlet sprawled in the valley on the broad flat just below the narrow gorge where Pine River rushed swiftly between steep high banks. But not once did he turn to look back at the cluster of houses or to glance up at the dazzling glory of the late afternoon sun on the clean crisp whiteness of the deep snow which covered the whole country.

With the worried frown deepening between his brows he mounted steadily until he topt the last rise and came out on a broad flat summit, where, in the midst of a large clearing, stood a cabin.

It was different from the usual mountain cabin in that it was long, narrow and low and windowed at but one end. Otherwise, except that from one end a span of glittering wireless antennae rose in a long slant to a tree at the edge of the clearing, it was quite the usual rough log structure.

Dick drew off his snowshoes at the door and stept inside without knocking. He found himself in a small room, evidently partitioned off from the main windowless apartment. Stove, bunk, a table spread with a litter of papers, and the other usual furniture made it seem like the ordinary cabin room. But at one side stood a table on which was spread the elaborate wireless instruments connected to the antennae wires. It was similar to Dick's set except that above the table was a row of carefully dialed instruments marked "Distance—height—speed—direction—shot control."

Dick had barely entered and drawn off his mackinaw when the door leading into the other room opened and a tall man whose erect military poise contrasted strangely with his grease-smeared overalls, entered.

Dick saluted.

"Good afternoon Captain," he said.

"Hello, Dick," the tall man replied, returning the salute. "What's the matter? Didn't the tests work right?"

"Oh, they were fine!" Dick answered. "It's old Tom Waldon again."

"Oh, your worthy constable and defender of the peace and safety of the commonwealth," Captain Hardy laughed, as he drew up a chair beside the stove.

"Its nothing to be laughed at," Dick protested, while the concern deepened in his face. "He's sent for a search warrant and is coming up here to investigate you and what you've been doing."

"Whe—e—e—ew!" the tall man whistled. "What's the matter now?"

"Number '6' fell in front of his house last night. He's all worked up about it and now he's certain you're a spy. The search warrant will be here tomorrow morning if the mail's on time; then he'll ransack the whole place. If he'd only keep his fool notions to himself and not try to be buttin' around into other people's business!" and Dick kicked savagely at a block of cordwood beside him.

"Of course I don't want to stir up any trouble," Hardy began thoughtfully. "You know I could resist search by him."

"But he's got the whole bunch worked up to believing the same as he does," Dick put in despairingly.

"Yes, that's true," Hardy replied. "But to come back to something more important, how did the tests come out?"

"I have the locations here," Dick replied, drawing a notebook from his pocket. "Number '6' fell in front of his place, and the rest—"

WATCH FOR THE SEPT. "E.E."

"X-Ray Tubes for High-Frequency Coils."—A subject of extreme interest to all those owning radio transmitting apparatus or high frequency coils, by Dr. Frederick F. Strong.

New Electro-therapeutic apparatus, by H. Rosenthal.

The Marvels of Radio-activity. Part II (with some wonderful illustrations), by Jerome S. Marcus, B.Sc., (Ch.E.)

Invisible Radio Aerials that "Spies" might use.

The first electric apparatus—The first incandescent lamp; the first dynamo; the first motor, et cetera.

A New Popular Scientific Article, by Rogers D. Rusk, B.Sc.

Selenium Cell, Design and Construction by Thomas W. Benson.

An Automatic Storage Battery Charger, by Lewis Scriven.

Making an Electric Clock—Part I, by Thomas Reed.

Are There Currents About a Magnet? by F. F. Mace.

The Franklin Electric Club, as founded by William J. Hammer, and his message to the "Electrical" and "Radio-Bugs" of To-day.

Unusual Entertainment Stunts with High Frequency Currents—With several startling photos of actual stunts.

Announcement of Prize Winners in the "What to do with your radio set during the war" contest.

Besides these leading articles the September number will fairly bristle with dozens of live, up-to-the-minute electrical, scientific and radio articles of interest to all of our readers.

For a half hour the two bent over a detailed map of the valley while they compared figures and locations.

"That's fine! The biggest variation is about four feet and that's corrected by the adjustments I've been making to-day," Hardy breathed in satisfaction, as he straightened up. "Now I think if we can run a test with a real charge instead of those dummies we can be prepared to announce results."

"I know a good target for it," Dick volunteered. "Its a big pile of drift and rubbish down by the bend just below town. Its doesn't belong to anyone. See—" and he pointed out the spot on the map.

"Good! Just the thing!" Captain Hardy endorsed. "What do you say we try it this evening? If your friend the eminent detective is to come up here to-morrow with his search party, we can tell him everything, if the test is successful."

"That suits me," Dick agreed.

"Very well," Hardy replied. "We'll set the time for nine o'clock then. Get your 'interference' going and we'll see how this tryout works."

"All right, sir. I'll be ready," Dick replied. "And I hope that warrant doesn't get here in time," he added as he smiled thru his anxious frown.

"Don't you worry about that," Hardy advised.

"Yes, but it makes me sick," Dick protested. "When a man's trying to do what you are and then for him to plot against you! It makes me want to hit him!"

"Oh, never mind," Hardy laughed. "Just you go to bed to-night and get plenty of sleep. We may have to run another test if this one doesn't work and I'll have to have you fresh and ready, because you're responsible for half the success of this thing."

"No—no!" Dick protested, while he blushed with pleasure.

"Yes, but you are," the tall man insisted. "I couldn't have done a thing without your 'interference' and the other ways you've helped. So just go along and forget that old spy-chaser."

But Dick could not shake off the thought of what the old man might do to wreck Captain Hardy's plans. All the way down the long white-covered slope he wondered and pondered, as he tried to find some way out of the complication into which his friend was drifting with the local officials.

"Has the mail come in yet?" he asked his father as he tramped into the kitchen and found the family at supper.

"No," Joe Preston replied. "The trail's getting too soft. That wind's melting the snow fast. Didn't you notice it?"

Then Dick remembered. While he had been in the big cabin on the top of Pine Mountain the wind had shifted to the south and with it had come balmy warm air which had rapidly softened the hard-crusted snow.

"I don't like this spell at all. There's too much ice and snow on," Joe Preston remarked.

But Dick rejoiced secretly. It might so impede the trails as to make it impossible for old Tom's search warrant to arrive in time from the Squire down the river.

His anxiety was gradually relieved as all that evening the warm south wind blew and the snow melted. It was dripping from the eaves in pattering cascades when he went upstairs into his room about eight thirty, after preparing his lessons for the 'morrow.

But he forgot it and even old Tom as he adjusted his wireless instruments carefully and cleaned all the contacts and tightened connections.

Then at a quarter before nine his call came in, "D P, D P, D P, H D."

"O K, H D, D P," he responded and the reply came back.

"Ready!"

Throwing over the aerial switch he set to work methodically. For the next fifteen minutes he sent anything and everything, stopping at intervals of several seconds to make swift changes in his transmitting wave length adjustment.

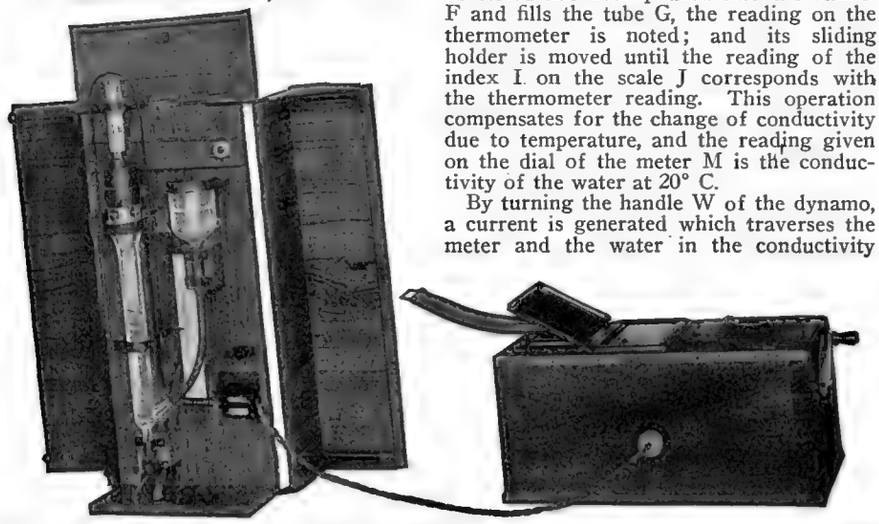
Then just as the hands of the watch which lay before him, pointed to nine, he heard faintly the muffled boom of an explosion from down the river, and with a satisfied sigh slipt off his receivers and crawled into bed.

Day had scarcely broken the next morning when he was awakened by an unusual sound. Sitting bolt upright in bed he listened for several moments before he recognized what it was.

(*Continued on page 279*)

Dionic Water Tester Operates by Electricity

WHAT is known as a dionic water tester has been recently perfected and appears to be an extremely practical apparatus for testing water, or any dilute solution. So simple and so direct is its operation that any unskilled person can make accurate tests, and even detect and measure traces of impurity so small as entirely to escape chemical analysis.



General Appearance of New Dionic Electric Water Tester. Operates on the Principle that Relative Chemical Make-up of Water and Its Electrical Conductivity Correspond.

The detection and estimation of impurities dissolved in water and the measurement of the strength of weak solutions have hitherto been carried out by chemical tests of more or less complexity. The dionic water tester involves the substitution of an extremely simple electrical meas urement.

When the nature of any substance in solution is known, the conductivity of the solution is a measure of its amount; and the dionic tester is therefore able, by a simple measurement of conductivity, to determine to a high degree of accuracy the strength of the solution under test. The weaker the solution, the more sensitive becomes the method, so that the instrument is peculiarly well adapted for detecting the contamination of water. Not only is it possible by the use of the dionic instrument to measure amounts of salt in solution too small to be detected by chemical means, but it performs in a few seconds, and in the hands of totally unskilled persons, work which a skilled man would take some time to carry out by chemical methods.

It does not, of course, discriminate between one kind of substance and another; analysis alone can do that. But in most instances in which water testing is carried out for engineering and kindred purposes, the substance present in the water is well known. Such tests are not made for purposes of analysis, but to find out how much of a known substance is present in the water; and in all these cases the dionic meter gives the required answer with a rapidity and simplicity unapproached by any chemical test.

The complete apparatus is shown here, where G is a glass tube to contain the water under test, and A and B are the electrodes for passing the electric current thru the water. The electrodes are connected by wires to a direct-reading conductivity meter M, and a continuous-current hand-driven dynamo E.

The thermometer T, measures the temperature of the water under test, and is capable of being lowered or raised in the water, so altering the effective cross area of the liquid path. This thermometer is supported in a sliding holder L, which moves in guides H, H, and which carries an index I ranging over a scale J, calibrated in degrees centigrade. After the water to be tested has been poured into the funnel F and fills the tube G, the reading on the thermometer is noted; and its sliding holder is moved until the reading of the index I on the scale J corresponds with the thermometer reading. This operation compensates for the change of conductivity due to temperature, and the reading given on the dial of the meter M is the conductivity of the water at 20° C.

By turning the handle W of the dynamo, a current is generated which traverses the meter and the water in the conductivity tube G. The pointer of the meter is deflected, and comes to rest at some point upon the scale which directly indicates the conductivity of the water in the tube corrected to 20° C. The test is completed as soon as the pointer has come to rest, that is to say, in two or three seconds.

The conductivity meter is a novel instrument; it measures directly, and without calculation, the conductivity of any electrolytic solution in the tube to which it may be connected. The indication is given by an index which ranges over an engraved scale, graduated in units of conductivity. Conductivity (specific conductance) is the reciprocal of specific resistance, and the most convenient unit for the purpose of water-testing is the reciprocal of one megohm. No one has given a name to the reciprocal of one megohm, and we must be content to call it simply one unit. In the conductivity meter for dilute solutions the scale extends from zero up to 2,000 units.

The tube is mounted in a strong teak case designed to be as compact as possible and when opened to afford a firm support for the tube during test. It is so constructed that by pouring water into the funnel F. and allowing it to overflow through the outlet pipe O, every part of the tube is thoroly washed out. A drain pipe D, of pure rubber, is provided at the bottom for the purpose of drawing off the contents at the conclusion of a test. Normally, the drain is closed by a pinch-cock. Water may be left standing in the tube for days at a time without the slightest trace of contamination from the rubber being traceable. All the user has to do in order to connect the tube to the meter is to push the plug into the socket.

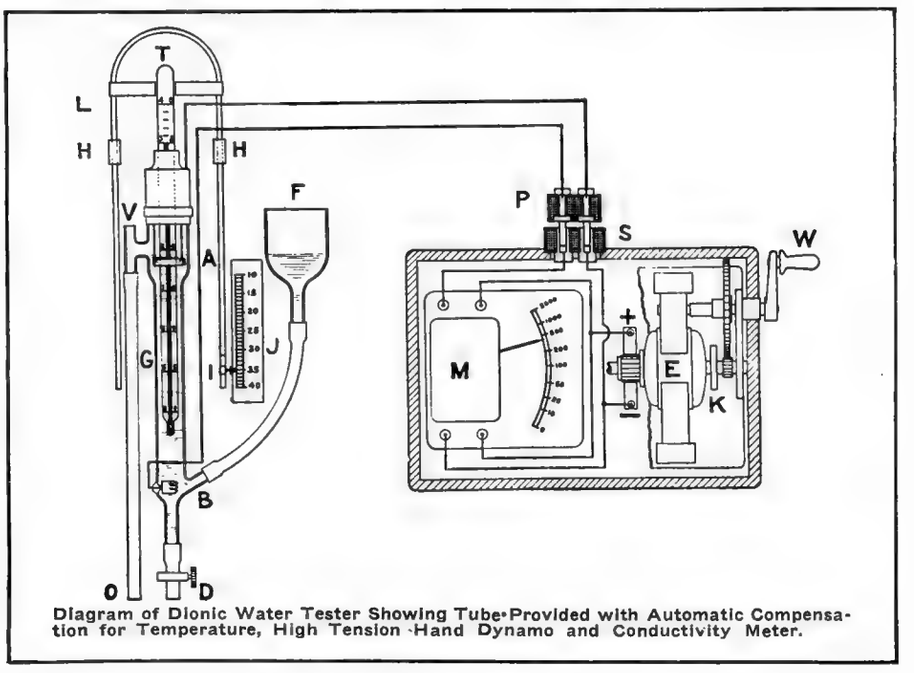


Diagram of Dionic Water Tester Showing Tube Provided with Automatic Compensation for Temperature, High Tension Hand Dynamo and Conductivity Meter.

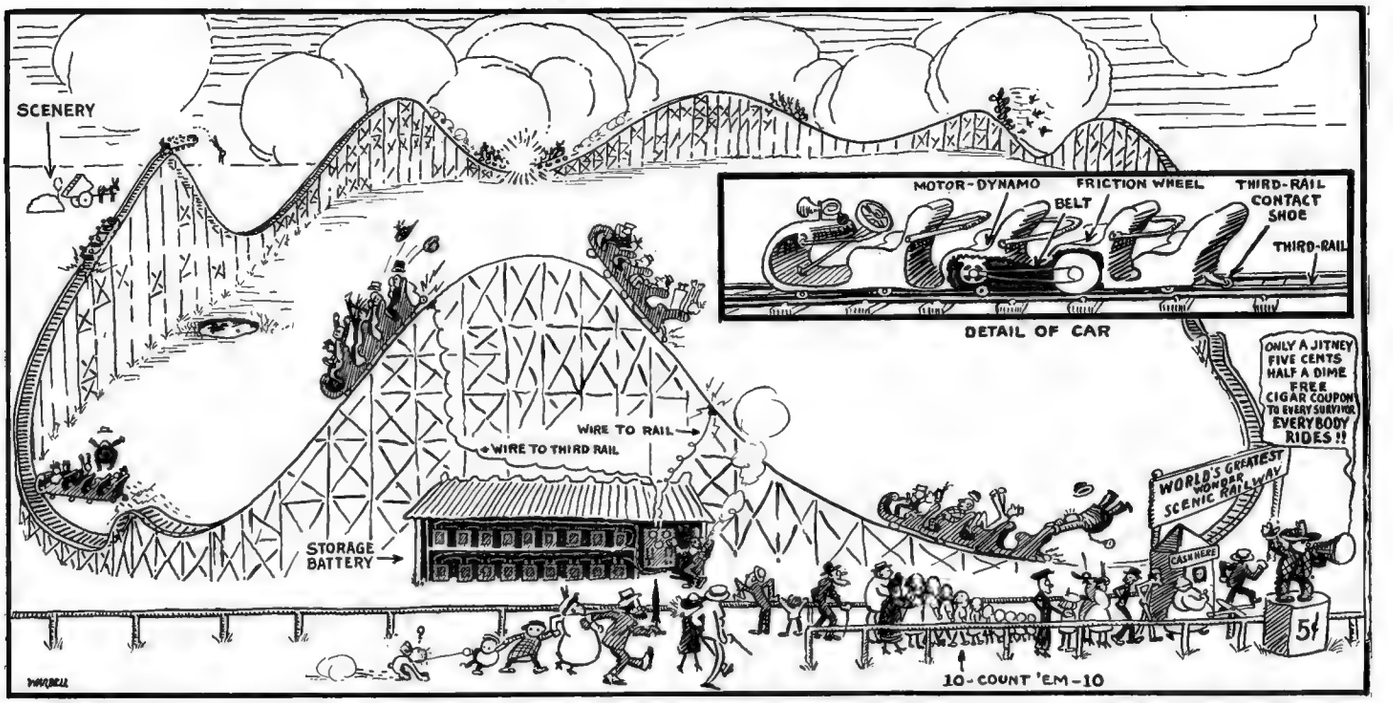
TWO NEW RADIO STATIONS FOR COLOMBIA.

It is reported that the two Marconi wireless outfits purchased by the Colombian Government some time ago will be delivered soon. It is intended to establish these two stations at Arauca and Orocue. The former is situated on the Arauca River where it forms the boundary between Colombia and Venezuela, and the latter is on the Meta River some 200 miles east of Bogota.

VALUABLE NEW DEPOSITS OF PLATINUM.

Platinum is becoming so scarce that Russia, where most of the mines are, is seeking new deposits. M. Chtein published in *Promichlennost i Torgorlia* last year a calculation showing that the Ural mines would be exhausted in from fifteen to twenty years. But the Russian paper *Gorno-Zadvodskoie Dielo* announces the recent discovery of a very rich deposit in the Vilyui River near where it flows into the Kundai, in the Yakutsk region. It is found mixed with gold in the sands of this river and its tributaries, from which the natives wash it and obtain an ore that is 50 per cent pure platinum and 50 per cent iridium, palladium and ruthenium.

"Perpetual Motion"



Here's Your Chance, "Electrical Bugs," to Become Internationally Famous. Design a Perpetual Motion Scenic Railway Like That Shown; the Descending Cars Pump Electrical Energy Back Into the Storage Battery; the Ascending Cars Are Helped Over the Peaks by Current from the Battery. For the Best 100 Words Explaining Why This Device Will or Will Not Keep Going For Years, Ignoring Wear and Tear, We Will Give a Year's Subscription to the "E. E."

WHEN your Editor was at the tender (?) age of eleven—yes, tough old birds like us were tender once, strange as it may seem—he had, just like the rest of us bugs, rather strange ideas about electricity and mechanics. Perpetual motion had a great and attractive fascination and appealed "mos' pow'fully" to his imagination. Yes, you said it—imagination is his middle name—altho, bless his dear ignorance, in those innocent days he was as yet not aware of the great axiom, to wit: "If you wish to lift yourself by your own boot-straps, do it in an elevator!"

Just like all budding electrical bugs, his first revolutionary invention consisted of the time-honored perpetual motion where you take a motor and a dynamo both of the same size, mind you, and connect them together by a belt. Then you connect the binding posts of the motor to those of the dynamo, and let 'er go! Of course you must give the belt a push, in order to start the rinktum going, that much is clear. In that case you generate a little current in the dynamo which feeds the motor. The latter in turn runs the dynamo by means of the belt. In a few seconds the system will run so fast that the dynamo—bless its soul—will have a generous amount of juice left over, which latter will feed all your various contraptions in your shop. Of course once started the system will run forever. Sounds fine.

Well, anyway, your Editor was one of those fool kids who did not believe in theory alone. Not him. He meant to try it out. He had a nice enough motor, but no dynamo. True, the patient old motor had been taken apart so often, and its field and armature had been rewound so frequently that it looked decidedly disreputable—but it ran, yes, on one Leclanché! Speak of a finely balanced armature! Well, after committing almost every imaginable crime on the bill of fare, with the possible exception of murder, enough cash was scraped together to send for that dynamo. In the catalog it said that it gave 4 volts and 4 amperes at 3,000 R.P.M. "Takes *remarkably* little power—can be driven nicely from a sewing machine, in order to charge storage cells, etc., etc."

Well, in those days, mail order firms were not so careful about their statements as they are today. At any rate your young hopeful for the benefit of all bugs in the Universe concerned, wishes to make public the fact that charging storage batteries with a dynamo from a sewing machine cannot be termed as a howling success. He tried it. Oh yes, frequently. Once for almost ten minutes at a time. For the first 19 seconds the dynamo ran at the prescribed 3000 R.P.M. It ran remarkably easy too. At the end of the first minute its speed had dropt to about 1100 R.P.M. At the end of the 10 minutes its speed had gone to *minus* 10 R.P.M. From this you will infer correctly that the storage battery now ran the dynamo as a motor, and the latter ran the sewing machine flywheel and the treadle! This was decidedly unpleasant. So he went at it again, first taking off coat and collar. This time he lasted eight minutes. But the storage battery got *some* juice in its carcass anyway, that afternoon. We should guess approximately 2¼ watts net. And next day, too, your Editor-to-be had such sore legs that he could not possibly walk. But it works. The catalog *was* right!

But we are running ahead of the story. At any rate, the dynamo soon arrived. It was a great day. Birds sang in the trees.

And the squirrel jumped hush, hush,
From the tree into the bush!

From this you have correctly deducted that it was a spring day. Ah, noble spring . . . and if we had been a trifle older we might have completed the "pome" with:

Maiden aunts grow sentimental
While the landlord claims the rental!

Luckily, however, we did not know oldish maids and their sentimental mental scents, nor were we as yet much troubled with ghoulish landlords.

At least we were not while we stood in a perfect trance before that dynamo, freshly unpacked, standing there in its virgin beauty of brightly red lacquered field castings, dazzling green magnet wire covering graceful limbs, and bright nickel binding posts, the whole mounted on a heavy real oak base. While we stood there gazing with love and admiration in our eyes, like a mother gazes at her first born babe, a delicious shiver ran up and down our back when we thought of the sumptuous monument that would garnish the public square which a thankful world had erected in our honor, after our death! The inscription was to read:

"To the inventor of the first Perpetuum mobile."

To make an unpleasant tale abbreviated, let us disclose the fact, that little time was lost in trying out the great invention. Everything was connected carefully, the belt was tightened correctly, and the bases of both motor and dynamo screwed down tight. The supreme moment had arrived.

We connected the wire to the last binding post and gave the belt a push—nothing happened. We gave it a harder push—an ominous quietude. What could be wrong? Ah, of course, oil! Mother's can of sewing machine oil was promptly secured and soon the dynamo and motor were drown-

(*Continued on page* 280)

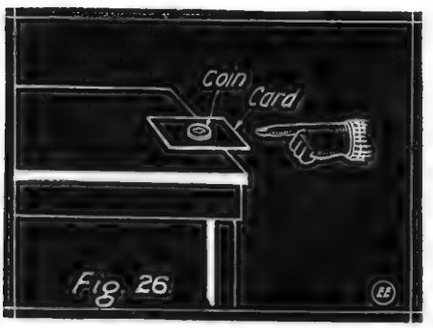
AMONG the hundreds of new devices and appliances publisht monthly in The Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnisht to you, free of charge, by addressing our Technical Information Bureau.

Experimental Physics

By JOHN J. FURIA, A. B., M. A.
Instructor in Physics and Science Master, Riverdale Country School

LESSON 6.
Newton's Laws.

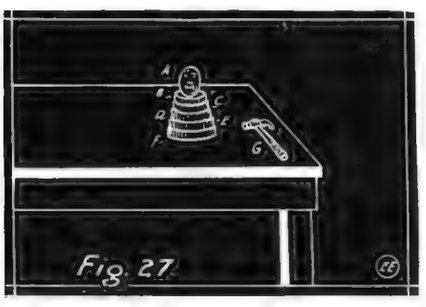
THE branch of Physics known as *Mechanics,* of which *Statics* and *Dynamics* are subdivisions, is conceded by scientists to be the foundation for all Physical Science if not of Science as a whole. Mach, in his "Science



A Simple Example of "Inertia." If the Card Is Snapt by the Finger It Will Fly Off, the Coin Dropping Directly Underneath Its Previous Position.

of Mechanics," says that since the time of Newton no essentially new principle has been stated but that all that has been accomplisht has been a deductive formal development of Mechanics on the basis of Newton's Laws. The man who establisht this basis two centuries ago was a truly great man if during all these years of excellent scientific research and discovery, no essentially new principle has been stated.

Sir Isaac Newton was born in 1642, which was the year in which the great Galileo died. While a boy, Newton spent a great deal of his time in constructing many mechanical toys. He didn't like school, and since he stood at the bottom of his class in scholarship, his teachers didn't like him. His thoughts instead of being on his schoolwork, were usually on other worlds than ours. Not being very healthy and being considered a dunce, he was bullied by the other boys. He stood for this as long as he could, and suddenly one day he "got mad and beat up the bully," who was first in athletics and scholarship. In his anger he developed great strength, and he himself was more surprised than anyone else to see the licking he gave the bully. That night he decided that if he could beat up the strongest boy in the class he could also study and beat him intellectually. Henceforth Newton stood at the head of



A Nifty Mexican Game. The Idea Is to Knock Out Each Block One by One, Finally Leaving the "Head" A, on the Table and In the Same Vertical Line. "Inertia" Again.

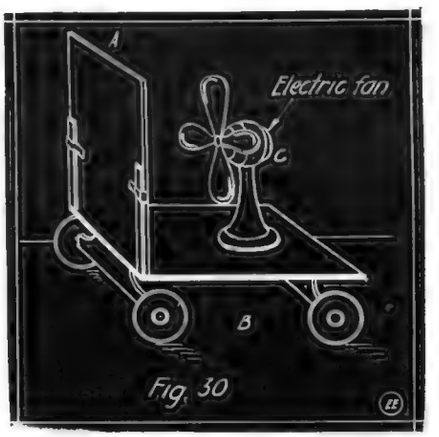
his class and was never bullied again. Therefore, my friends, if you find that you are at the bottom of the class or not up at the very top, beat up the strongest bully of the class and then study hard and get first place, and perhaps you will be second Newtons. While an undergraduate at Trinity college he studied the works of Galileo, Huygens and Keplar, became interested in mathematics and physics, and paved the way to his great future contributions to those sciences. At his death in 1727, he left those sciences establisht on a firm foundation. He was a great scholar, not only in his field, but also in the Classics and hence we are not surprised to find his great work the immortal *"Principia"* written entirely in the Latin language.

Among his many contributions, and first in importance, was his formulation of what are known as Newton's Three Laws of Motion. He stated them as follows:

LAW I. Every body perseveres in its state of rest or of uniform motion in a straight line, except in so far as it is compelled to change that state by imprest forces.

LAW II. Change of motion (i. e., momentum) is proportional to the moving force imprest and takes place in the direction of the straight line in which such force is imprest.

LAW III. Reaction is equal and opposite to action; that is to say, the actions



Illustrating "Action" and "Reaction." With Board "A" Removed the Fan Propels the Wagon; With "A" in Place the Wagon Stands Still.

of two bodies upon each other are always equal and directly opposite.

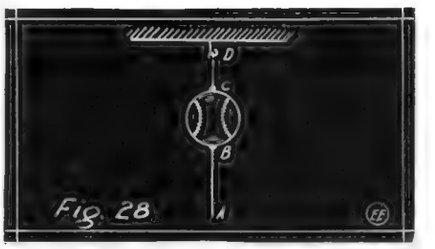
Among Newton's definitions, these two are of especial importance in connection with his laws of motion:—

DEFINITION II. Quantity of motion is the measure of it by the velocity and quantity of matter conjointly.

DEFINITION III. The resident force (i. e., the inertia) of matter is a power of resisting, by which every body, so far as in it lies, perseveres in its state of rest or of uniform motion in a straight line.

These laws are to be regarded as axioms incapable of rigorous experimental proof. The most powerful argument for their validity rests on the fact that their application to the solution of problems in Physics and Astronomy leads to results that always agree with these of observation. For example, the time for a coming eclipse is calculated by assuming the truth of these laws and the remarkable agreement between the calculated time and the subsequent observed time confirms the laws.

EXPERIMENT 31—Take a ride in the subway. You will notice that the company very generously furnishes straps to hang on. Newton's Laws are responsible for making the company adorn its trains with straps. (If you live outside the city and have not had the opportunity of riding on the straphanger's route, by all means take the first train for the city and enjoy this "pastime".) The

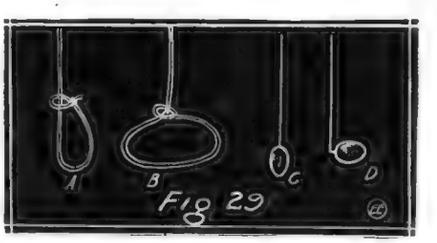


By Means of Thumb-Tacks, a Baseball Is Suspended as Shown. Pulling Suddenly on Thread at "A", It Breaks Between "A" and Pin "B"; Pulling Slowly the Thread Parts Between "C" and "D".

bodies in the moving train tend to move toward the *rear* of the train when the train starts, and toward the *front* of the train when the train stops. This serves to illustrate Newton's first law, that a body in motion tends to keep in motion and that a body at rest tends to stay at rest. (This experiment is apt to prove unsuccessful if tried during the rush hour, when we are packed so tight that we cannot move.) If the train should turn a curve while in rapid motion we are thrown into the lap of a pretty young girl or (if we are sitting) said young girl falls into our lap and we are duly thankful for Newton's first law in either case.

EXPERIMENT 32—If father should be after you for having gone to the ball game instead of to school (he having seen you by going to the game instead of to work), run into the dining room and grasp the rug firmly in both hands. As he enters the threshold, pull the rug and he will sit down on the floor in great haste, thus giving you ample time to escape. This is a case of the First Law—Pa's body tended to stay at rest while you pulled his feet from under him.

EXPERIMENT 33—Another interesting phase of this experiment, which you can try on a good friend (preferably one who can't lick you), is as follows: Ask your friend to place his right foot behind and to the left of his left



Several Interesting and Easily Performed Experiments to Demonstrate the Law of Centrifugal Force.

foot. Then let him place a long pole or broomstick on his right toe, holding the pole loosely in his left hand. Count three slowly and have him kick out rapidly at the word three to see how far he can send

(*Continued on page* 281)

The RADIO LEAGUE of AMERICA

HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.

H. Gernsback, Manager *W. H. Kirwan, Master of Radio Relays*

Mr. Amateur, This Means You.

By THE EDITORS

THERE are still a few amateurs scattered over the country, who fail to comprehend that this nation is now engaged in the most stupendous war the world has ever known.

Being at war is a mighty serious business and it is not good patriotism for a few thousand disgruntled amateurs to pass judgment upon our government. Whether we think that the Navy Department acted wisely or not in depriving us of our stations, is of small concern to the nation at large. At any rate, the facts are that we can't use our outfits the same as before, and being placed in this position, we must try and make the best of it, as good and law abiding Americans should do.

On the other hand, we should show a little more spunk than we have shown during the past three months. It is decidedly un-American to "chuck up" our hands and say:

"Oh, well, what's the use. Wireless is as dead as the Dodo. Forget it!"

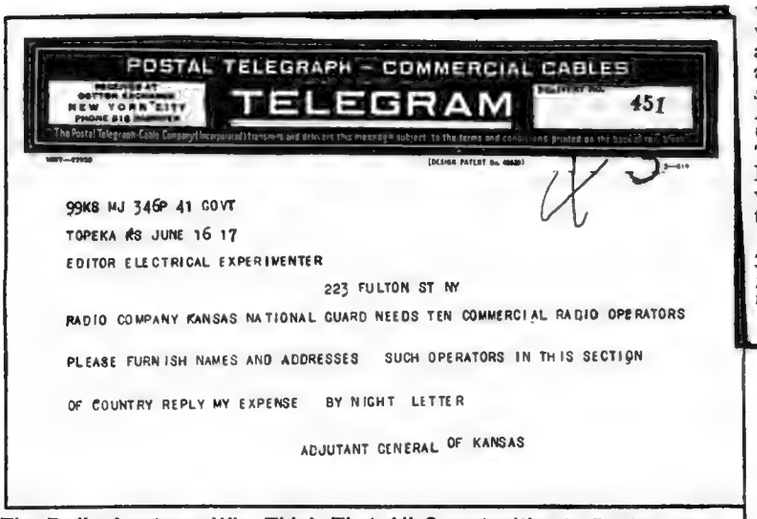
And this is just what a few chicken-hearted Amateurs have been doing. Luckily our reports show that their numbers are far from large. Things are beginning to shape themselves nicely. The situation is becoming rapidly better; there is a light gray mist where last month there was nothing but inky darkness. The Navy begins to see that the curbing of Amateur Wireless has proved a boomerang. Operators are becoming scarcer than hen's teeth, and we need countless thousands of good operators. How to get them quick? In Philadelphia the Navy Department a few weeks ago took over a private wireless school in order to speed things up. As we go to press a government official calls on us asking for a list of all New York and vicinity Radio Clubs in order to get in touch with them and keep their interest in wireless alive. Reason: The government needs lots of operators. It will get most of them from the amateur ranks. Yes, perhaps you don't believe it, but the Government is with us now, not against us.

We think we will have some good news for you next month. Don't think that we are asleep, and if some of you have given up the ship, the Editors have NOT. So watch! The telegram and the letter reproduced herewith speak volumes to any amateur *who wants to see the light.* Amateurs, GOOD AMATEURS, not Hams, are wanted more than ever.

It's up to you if you prefer the trench to the Radio tent behind the lines. You can be heroic and manly in either. Which do you choose? But you must know your business, and if you are a "ham" now, go to some good radio school or if you cannot do this take a correspondence school course. Then again as a beginner, you can drill at home at little or no cost. There are a number of good instruments with which to learn how to send and how to receive the code. In less than three months you can be an expert in sending and in receiving, with an outfit operated right at home. An hour a day suffices. If you have a radio outfit, keep it in good trim, even if you can't connect it to an aerial. After that go to a good radio school and "brush up." Also with a simple buzzer arrangement, you can send yourself messages, using your receiving apparatus, and no aerial. A muffled or silent buzzer along side of you will send out sufficient waves across the table, to be audible in your receiving apparatus. This makes for efficiency, as very careful and sharp tuning is necessary. Besides it is not against the law, and also it keeps you in trim.

Next month we will have a lot of new stunts, *"What to do with your Radio Outfit."* Several thousand suggestions—some *very* good ones—have already been received.

In the meanwhile, "don't give up the ship." As "Fips," our dear office boy, was wont to say: "It's an ill wind that has no silver lining!"



POSTAL TELEGRAPH - COMMERCIAL CABLES

TELEGRAM 451

99K8 MJ 346P 41 GOVT

TOPEKA KS JUNE 16 17

EDITOR ELECTRICAL EXPERIMENTER

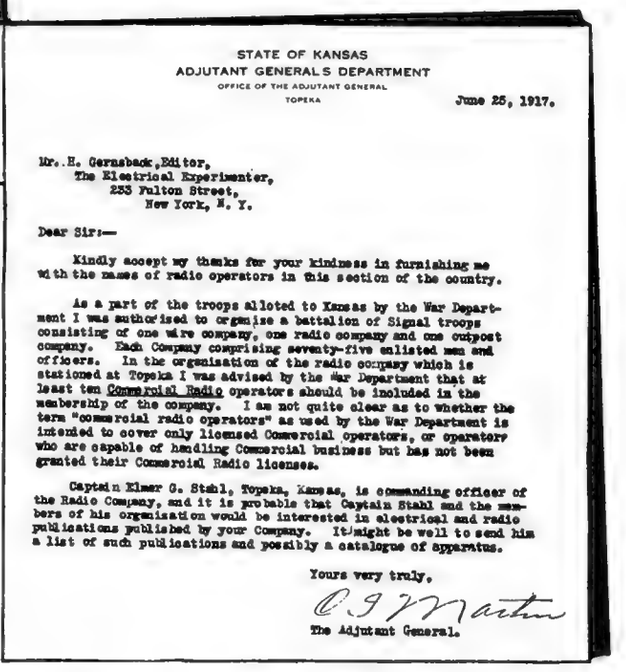
223 FULTON ST NY

RADIO COMPANY KANSAS NATIONAL GUARD NEEDS TEN COMMERCIAL RADIO OPERATORS

PLEASE FURNISH NAMES AND ADDRESSES SUCH OPERATORS IN THIS SECTION

OF COUNTRY REPLY MY EXPENSE BY NIGHT LETTER

ADJUTANT GENERAL OF KANSAS



STATE OF KANSAS
ADJUTANT GENERAL'S DEPARTMENT
OFFICE OF THE ADJUTANT GENERAL
TOPEKA

June 25, 1917.

Mr. H. Gernsback, Editor,
The Electrical Experimenter,
233 Fulton Street,
New York, N. Y.

Dear Sir:—

Kindly accept my thanks for your kindness in furnishing me with the names of radio operators in this section of the country.

As a part of the troops alloted to Kansas by the War Department I was authorized to organize a battalion of Signal troops consisting of one wire company, one radio company and one outpost company. Each Company comprising seventy-five enlisted men and officers. In the organization of the radio company which is stationed at Topeka I was advised by the War Department that at least ten Commercial Radio operators should be included in the membership of the company. I am not quite clear as to whether the term "commercial radio operators" as used by the War Department is intended to cover only licensed Commercial operators, or operators who are capable of handling Commercial business but has not been granted their Commercial Radio licenses.

Captain Elmer G. Stahl, Topeka, Kansas, is commanding officer of the Radio Company, and it is probable that Captain Stahl and the members of his organization would be interested in electrical and radio publications published by your Company. It might be well to send him a list of such publications and possibly a catalogue of apparatus.

Yours very truly,

C. J. Martin

The Adjutant General.

The Radio Amateurs Who Think That All Opportunities to Do Something Worth While Have Ceased Will Do Well to Note the Accompanying Official Recognition of the Service Which the Radio League of America Will Be Called Upon to Furnish Right Along. The Moral Is Mr. Amateur—"Prepare!"

ALL RADIO AMATEURS ATTENTION!

The Navy Department has been delegated by our President to close all amateur or experimental radio stations, no matter whether equipt for transmitting or receiving, licensed or unlicensed, and therefore we shall all have to abide by this decree, whether we like it or not.

Therefore, "THE ELECTRICAL EXPERIMENTER," will endeavor to feature the Electrical Laboratories in preference to any radio stations in the awarding of the monthly prize of $3.00 in this department. Now is the time to get busy and freshen up your electrical apparatus, and incidentally improve your understanding of electrical matters, which perhaps you have unwittingly slighted to a large degree in your pursuit of radio-telegraphy. Let her go, boys!

Bell Telephone Engineers in U. S. Signal Reserve Corps

THE Signal Corps forms one of the most important divisions of any army. The U. S. Signal Reserve Corps have had the good fortune to enlist in their ranks some of the best telephone, telegraph and radio engineers in the country. The extensive and ever progressive Bell Telephone System has, among numerous other worthy accomplishments, developed a particularly efficient engineering staff, comprising thousands of men, practically all college-trained and men who have proven ability in these now supremely important branches of applied electricity. This widespread organization has had not only the problem of furnishing trained officers and men to the Signal Reserve Corps, but also to face the gigantic task of maintaining its nation-wide lines of communication which it had built up.

The presidents of the various Bell Companies thruout the United States at a conference held in New York in November, 1916, approved a plan which had previously received the approval of the directors of the American Telephone and Telegraph Company, to encourage the formation from the telephone companies' personnel of a reserve of officers and men, in accordance with the provisions of the National Defense Act of June 3, 1916. This plan had received the approval of the Army authorities.

In March, 1917, the detailed plan was presented to the employees of the Bell System thruout the country, with an opportunity given all men from eighteen to forty-five years old to volunteer.

Mr. J. J. Carty, chief engineer of the American Telephone and Telegraph Company, had received his commission from President Wilson as senior major, and twenty-five Signal Corps Reserve companies were to be formed from the Bell operating companies, each company to be made up of one captain, two first lieutenants and an average of about one hundred non-commissioned officers and men, with one major and an extra lieutenant (his adjutant) for each two companies, a total of about one hundred officers and 2,500 non-commissioned officers and men.

The New York Telephone Company was to provide five of these companies. A total of 2,871 volunteered. Two companies have been formed from the Manhattan-Bronx and Westchester Divisions, one from the Long Island Division, one from the New Jersey Division, and one from the Albany-Syracuse-Buffalo districts.

In addition a number of the engineers of the Western Electric Company have been commissioned in the Signal Officers Reserve to do special development and research work in connection with wireless and other systems of communication. Maj. F. B. Jewett is the ranking officer in charge of this work and will be stationed in New York. Maj. N. H. Slaughter is in direct charge of the radio development work in Washington, where he will have a separate organization reporting to him, which he is now engaged in organizing.

As war with Germany had not been declared when the plan was put into effect, provision was made for employees who joined the Signal Reserve Corps during times of peace, as well as in times of actual or threatened hostilities. The following regulation is in force since the country is now at war:

Leaves of absence will be granted to such employees when ordered to duty by the President of the United States in time of actual or threatened hostilities. Such leaves of absence will be subject to the following conditions:

"(*a*) The leave will cover the period of the employee's necessary absence on such duty during the remainder of the term of the commission or enlistment under which he is serving at the time he is ordered to duty, and during renewals thereof in time of war.

"(*b*) The employee will be allowed full pay, at the normal rate in effect when he is ordered to duty, until the end of the calendar month in which he is thus called into service; thereafter, for the period of leave of absence, but not exceeding twelve months, he will be allowed full pay at such normal rate less the amount which he is entitled to receive from the Government. If the necessary absence on duty continues beyond such twelve months, further consideration will be given to the matter of payment.

"(*c*) The employee will retain his eligibility to benefits under the 'Plan for Employees' Pensions, Disability Benefits and Death Benefits' during the period of leave of absence, and such period of absence will not be deducted in computing his term of employment for purposes of said Plan.

"(*d*) Upon return from such duty (after honorable discharge if the employee has left the United States military service), the employee will be given such employment as the needs of the service permit and as he is able and fitted to perform."

These officers and men of the Bell System, trained and experienced in "the art of construction and maintaining telephone and telegraph lines," have been accepted and commissioned by the Government, and are being instructed in military duties.

A Group of Future U. S. Signal Reserve Corps Engineers Receiving Instruction in the Engineers' Conference Room, American Telephone and Telegraph Co., New York City.

MEXICO CITY RADIO MAY REACH GERMANY.

The accompanying photograph shows the new wireless station erected close to the Castle of Chapultepec in the City of Mexico. The Mexican government has had a wireless station at that point for several years, but it was practically useless, because, it was said, the towers for the aerials were not high enough. They were 85 meters high, or about 278 feet. Recently the towers have been made higher. They are now 125 meters high, or 410 feet, and one of these towers is shown in the accompanying photograph. The other tower is not in the picture, but the supporting stay wires leading to its top may be plainly seen to the right.

Photo from New York Herald.

One of the Gigantic Steel Radio Masts, Each 410 Feet High, in Mexico City. This Plant It Is Thought Can Easily Communicate With Germany.

While this wireless station is owned and operated by the Mexican government, it is common talk in Mexico City that the recent additions and improvements have been made possible by German capital and that the station is of far greater value to the Germans than to the Mexican government. Mexico, it is indicated, has no merchant marine and practically no navy, so that the erection of an expensive wireless station at the capital would seem to be a useless and superfluous luxury.

A Mexican account says "that the wireless station installed at Chapultepec has been communicating directly with the North American city of Houston, in the State of Texas, and with some cities of South America, especially Panama.

"This fact signifies that our wireless service is improving daily and that its field of action is extended more and more."

The inspired "explanation" of why Mexico has suddenly added such a powerful station to its wireless service—to be prepared to report merchant ships after the war ends in Europe—has been received with some amusement by foreigners who read it in Mexico City in the government organ. It was commented that the station might be of far greater value to German submarines in Gulf waters if possibly the Zimmerman note inviting Mexico to become an ally of Germany should prove to be something more than a mere "scrap of paper."

It is said that there is another wireless station in Mexico somewhere near Salina Cruz, as well as the one installed between the towers of the parochial church in Tampico, the latter having been transferred from the interned Hamburg-American steamship Antonina at Tampico.

It is known that Mexico City has been holding wireless communication with San Salvador and also with Colombia, and it is also known that the German Minister in Havana has received mysterious wireless messages having to do with Mexican affairs.

MOST ANYTHING SERVES EXPERT FOR A WIRELESS.

The police at the Second Precinct station in Cleveland, O., recently received an impromptu lesson in wireless that curled their hair and left them wondering.

A. D. Silva, equipment expert, was taken to task because police thought he had not dismantled his wireless plant in compliance with the President's order.

"But I took down my aerial," protested Mr. Silva.

"Won't do—you must take your instruments off the table—put them out of commission," explained the police.

"But I can sit right here in this room, and with materials you see on this desk I can make an outfit with which I can receive from a distance of 200 miles," said Mr. Silva.

Whereupon he took the sergeant's safety razor blades, a pencil, a telephone receiver, some wire and—(deleted by censor)—gave a demonstration that proved so interesting that it lasted for two hours.

"Or one could do the same with clock parts—if he knew how," said Mr. Silva.

KEEP UNIV. OF PENN. WIRELESS OPEN.

Permission has been granted the University of Pennsylvania by the Government to keep its wireless station open for the receiving of messages, but no messages will be sent. Eight members of the wireless class have agreed to watch the apparatus to prevent tampering with the station and to pick up any enemy messages that might be sent from hidden wireless plants nearby.

In the past two weeks thirty-two undergraduates have enrolled in the Signal Corps of the students' battalion and are receiving instruction in wireless work. Experienced drill sergeants are needed at once for the University battalion, in which nearly 2,000 students have enrolled. Men who have had experience in military schools, the National Guard or the regular service will be accepted, and will be on duty each afternoon from 1 to 6 o'clock. The pay is $45 a month.

OSCILLATORY DISCHARGES.

Ten little coulombs looking jolly fine,
One was discharged, and then there were nine.

Nine little coulombs made to oscillate,
One jumped a spark gap, and then there were eight.

Eight little coulombs sent off to heaven,
One became earthed, and then there were seven.

Seven little coulombs playing funny tricks,
One strained the ether, and then there were six.

Six little coulombs looking quite alive,
One got damped, and then there were five.

Five little coulombs feeling somewhat sore,
One got resisted, and then there were four.

Four little coulombs in a battery,
Someone switched the current on, and then there were three.

Three little coulombs wondering what to do,
One got polarized, then there were two.

Two little coulombs, after all this fun,
One caught hysteresis, and then there was one.

One little coulomb, feeling rather glum,
He was short-circuited, then there was none.

—R. C. D., in *Wireless World*.

"How to use your radio instruments for short range communication without aerials (sending and receiving)" is the title of an article to appear in the September "E. E." Don't miss it, "Radiobugs!"

THIS RADIO MAST RESEMBLES EIFFEL TOWER ON WHEELS.

Herewith is pictured one of the newest inventions for military purposes. It is a portable wireless telegraph outfit, mounted on top of a fast automobile. The transmitting and receiving apparatus is connected to a latticed steel aerial tower which looks like a miniature Eiffel tower and has a hinged top which may be raised and lowered as desired. The contrivance attracted much attention when it was recently driven about the streets of New York City.

It is possible to transmit and receive radio messages while the car is moving at any speed. It is intended to be fitted with machine guns and may serve as an elevation from which to signal by wig-wag flags or by heliograph.

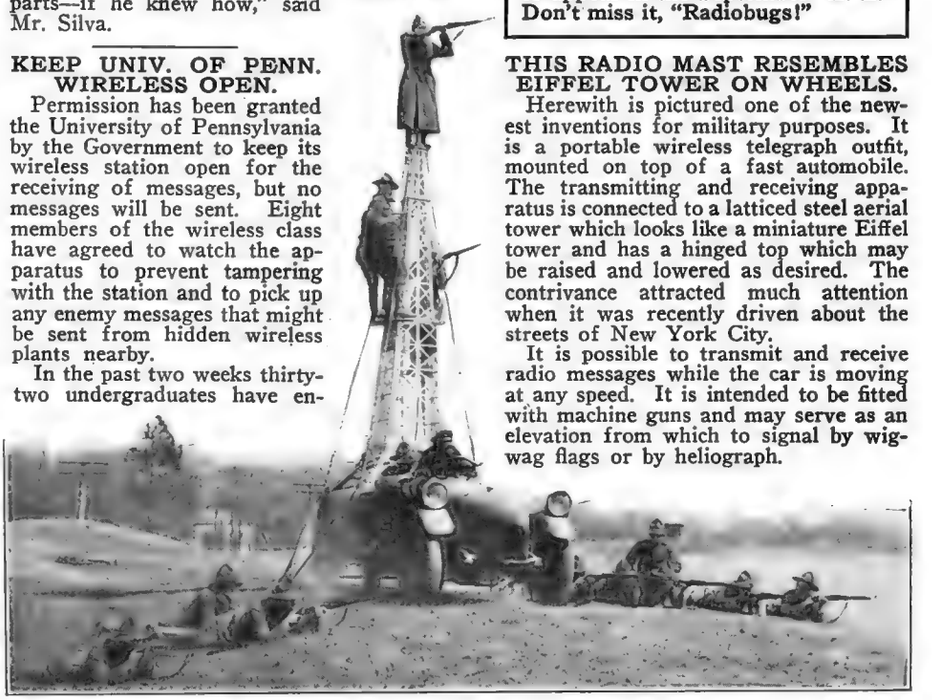


Photo by American Press Association.

The Newest Combined Radio, Signal and Observation Tower Mounted On Fast Auto Truck, Which Is Being Used By U. S. Signal Corps.

The Amateur and Experimental Radio Research

By RAYMOND FRANCIS YATES

Part II—Suggestions for Research Work

WE may bring radio research work under two general captions. (1)—That involving the electrical and mechanical design of instruments without changing the theoretical principle. (2)—That involving the design of apparatus that operates on a new theoretical principle. During the past few years, many new instruments have been invented that would come under the first classification. We have seen scores of new detectors, tuning transformers, variable condensers—et cetera, that possess the same basic principle of operation but differ only in mechanical design. In many cases, the manufacturers permit novelty of design to interfere with the most efficient construction of the instrument, and this is indeed a mistake. There is much in the design of an instrument, but novelty plays the smallest part. Those experimenters who wish to invent new designs should first assure themselves that their new design will give greater satisfaction in either one of the following ways; *i. e.*, efficiency, (first and foremost), economical construction without loss of efficiency, and convenient manipulation. The design of instruments forms a very lucrative field of research and experiment for the amateur and it is indeed encouraging to see that many amateurs in the United States have invented new instruments of merit and practicability. Eugene V. Turney of New York City offers a splendid example of the work experimenters, who possess a little originality, can do in the way of new designs. If an instrument can be built more cheaply, function more accurately or efficiently, or made easier to manipulate, it can find a place of ready sale on the market and its inventor will be well paid for his effort, both in money and in distinction for advancing the art. The man that found that comprest air was preferable to glass as a di-electric in condensers discovered a new principle of great importance, yet most any amateur could have made the same discovery.

An Experimental Poulsen Arc Will Prove Extremely Valuable for All Classes of Radio Measurements and Tests with Dummy Antennae. This Piece of Apparatus Should Be Found in Every Radio Experimenter's Laboratory. It is Provided with Gas Jacket and Water Cooled Anode.

We find very few new instruments on the market that operate on a new basic or theoretic principle. There are many cases where an instrument can be designed so that it will accomplish a certain function by a different fundamental principle. The Audion is a good illustration. It is a substitute for an ordinary detector that not only operates on a new principle, but performs its part more efficiently. There are many instruments that would perform more efficiently on different principles. Thus, the *quenched* spark gap operates differently than the rotary and the variometer differently than the tuning transformer. In some cases, mechanical and electrical design are so closely related that we cannot alter one without considering the other.

Aside from the invention of new instruments and the discovery of new principles, the problem of hook-ups also forms an important field for wireless research work. There is much in the method of connecting a wireless outfit and our present systems are as young and undeveloped as wireless itself, and it is only logical to conclude that, as the art advances, so must the methods of connections and many important changes will take place. In many cases, patents may be procured on wireless hook-ups and if an experimenter really discovers a method of connection that increases efficiency, he may protect it and in all probability realize something from it.

Question—What Is There to Invent?

The room for improvement is so great and the multitude of suggestions so vast that it would indeed take a volume to cover them. In the following we will outline a few of the more important and popular problems of the day.

At the present time the Audion detector is not being used by many amateurs because it is too expensive to operate, due to the cost of the flashlight batteries. Is it not possible to find means that will obviate the necessity of using a high potential battery? It indeed seems very reasonable that the basic construction of the Audion can be changed to accomplish this result. If this cannot be done, why not invent a "new" Audion that will possess this desirable feature? Another possibility of improvement in the "Audion" is in the fact that a glowing filament is not the only agency that will produce ionization in a vacuum. If some other agency could be utilized, "Audions" could be constructed that would last forever.

Another conspicuous problem of the day, and one that is preventing progress in radio-telephony, is the heavy-current transmitter. At first thought, this is a seemingly simple problem, but this is not so, as many great minds have worked on the problem and there is yet a great fortune in store for the inventor of a real practical arrangement.

The spark gap of today, whether rotary or quenched, is a very inefficient instrument and an extravagant user of energy. Will it ever become possible to make a circuit oscillate without a discharge in connection with a transformer? If such a discovery was made, the high-frequency alternator would probably never need to be perfected.

While the high aerial today forms an indispensable part of a wireless equipment, without a doubt, it will be entirely obviated in the equipment of the future. At the present time experiments are being carried on with a "concentrated" aerial and it has been found to give remarkable results. The "concentrated" aerial is probably the fore-runner of the aerial of the future. It is only logical to conclude that the aerial of the future must be small, for at that time man will have perfected transmitting instruments to such a degree of efficiency, and brought receiving apparatus to such a point of sensitivity, that the large and lofty aerial will no longer be necessary. The question today is, what type of concentrated aerial is the most efficient? This is, of course, left open to experimental determination. When we realize that the greatest item of expense in a powerful radio station, is the aerial-supporting towers, we can readily conceive what an important

The Spark Gap of To-day, Whether Rotary or Quenched, Is a Very Inefficient Instrument and an Extravagant User of Energy. Why Not Try to Find a Substitute for It?

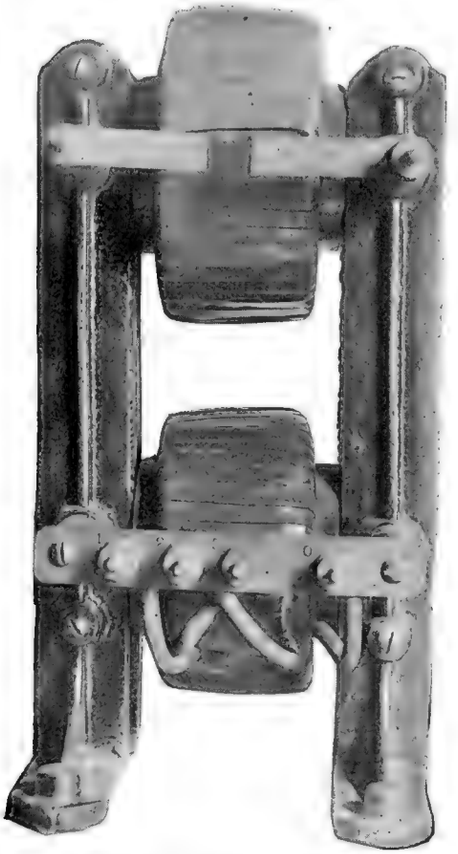
question it really is. Many may be inclined to say that it is too early to experiment with the "concentrated" aerial, but this is not so as that degree of perfection in radio apparatus is so rapidly approaching that this type of aerial will soon be a necessity.

Every instrument in a radio equipment, no matter what it is, represents only a small degree of efficiency. The 'phones, condensers, tuners, detectors, gaps or transformers are all in the embryo state. To obtain suggestions for improvement, the experimenter need only sit down at his instruments and gaze at them, at the same time analyzing each one and asking himself where and how they can be perfected.

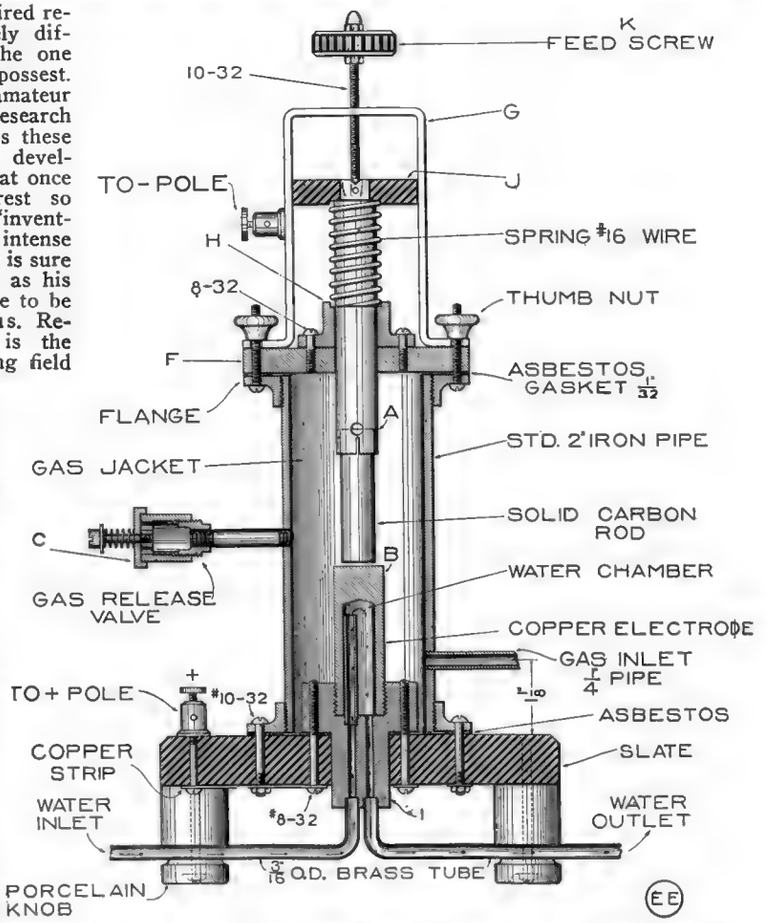
Methods of Attacking Problems

Before entering into research on any special subject, the experimenter should first properly prepare himself in what may be called the "preliminaries." If his idea concerns tuning transformers, he should not depend wholly upon the knowledge he already has in connection with this particular instrument, but should go further and make a complete study of it. Every available bit of literature should be read. Probably the idea has been tried before, or it may be that during his investigations he will conceive of a better way to accomplish his object. Above all, he must know the theory and operation of the instrument he is concerned with. Every experiment he makes should be inspired by a definite conception of the circumstances and conditions to be involved as well as a concrete pre-determination of the result being sought. An experimenter may start a certain investigation with an isolated idea of the result he wishes to obtain, but as he gets into the practical research work, he will be surprised to find that his idea is suffering evolution. If it has no evolution, something is wrong, for when an idea is put to practical test, one invariably finds many ways of improvement, and, in many cases these are so numerous and severe that our later conception of obtaining the desired results is entirely different from the one we originally possest. When an amateur gets into research work and feels these circumstances developing, he will at once find his interest so keen and his "inventing mood" so intense that something is sure to come of it, as his efforts are sure to be conscientious. Research work is the most interesting field of endeavor open today, and it is safe to say that without proper and rigid investigation — *Research* — no important invention will be made. There are exceptions to every rule, but it is invariably true that, we cannot get something for nothing.

The best paid radio and electrical engineers to-day are those engaged in research work. But they must be thoro in their knowledge.



A Common Form of Step-up Transformer Used for Radio Transmitting Purposes. There Should Be Many Opportunities Offered in This Direction for New Ideas.



Sectional View of ½ K. W. Experimental Poulsen Arc for Radio Requirements (See Opposite Page Also), which the Radio Student Will Find Highly Interesting and of Many Uses in Various Investigations and Tests. It Has Talked Wirelessly 25 Miles. Excitation Is By Direct Current.

MUSIC BY WIRELESS

Tina Lerner's Playing on Board Ship Heard on Other Vessels 500 Miles Away

Imagine sailing on a ship in mid-ocean and being able to hear your favorite pianist in a concert that she is giving on board a vessel hundreds of miles away! The possibility is not so remote as one might surmise, for on Washington's birthday last, Tina Lerner, the distinguished young Russian pianist, gave a recital on board the Ventura on her homeward journey from Honolulu, and enjoyed the unique thrill of feeling that her music was being heard by wireless operators on board passenger and freight steamers as far as 500 miles away.

In the concert room where Miss Lerner was playing, a transmitter was placed, and by means of a recently perfected wireless telephone apparatus, the music was sent out over a large radius.

The experience of listening to this concert was far more novel than participating in the demonstrations which have recently been tried successfully, when singers and speakers in San Francisco were heard at meetings and banquets in New York and other cities. At these functions the guests were provided with telephones thru which they heard every tone distinctly. Even the applause that the singers received on the Pacific Coast was accurately transmitted, and all the thrills that attended the real concert were felt by this "proxy audience" on the other side of the continent.

That, however, was over telephone wires. To play the piano while isolated in mid-ocean and have the notes float thru the air and bring pleasure to those far distant, does much toward the complete annihilation of space and causes us to wonder what tomorrow may bring forth.

When we are far from home—and think of the loved ones left behind, shall we be able to commune with them thru music?

NAVY RESERVE WANTS WIRELESS OPERATORS

An opportunity for amateur wireless operators having a knowledge of wireless or land telegraphy to join the navy reserve force was announced at the Great Lakes training station at Lake Bluff recently. It was stated that radio operators soon will be needed and that facilities for giving the instruction have been provided by the navy.

Heretofore the number of radio operators who responded to the call to the colors has been so great that all positions were filled, the schools of instruction were overcrowded and all enlistments in the branch had to be stopt until further arrangements could be made.

PROF. TAYLOR DIRECTS U. S. RADIO.

Professor A. H. Taylor of the physics department, University of North Dakota, was recently appointed district superintendent of communication at the Great Lakes Training Station. He is a radio expert and has been given the rank of lieutenant in the Navy.

"ELECTRO"

THE "ELECTRO" CODOPHONE

(Patents Pending)

AMATEURS! ATTENTION!!

Now that we are for the time being, deprived of using our Radio outfits, it behooves us as good Americans to become proficient in learning the Wireless as well as Telegraph Codes. Operators who know the Code are, and will be, in ever rising demand. The Army and Navy need thousands of operators right now.

So far the Government has not been able to obtain any way near all the operators it requires. Not alone does the Federal Government call for thousands and thousands of operators for the army and navy, but nearly all of our many states require operators for the militia. Here is the great opportunity of a life time for you.

Would you rather fight in the trenches, or punch the key behind the lines? Either way you benefit your country. **Which do you prefer?** And it is SO easy to become an operator. You do not necessarily require a teacher, nor do you have to go to a school to learn. 30 days of intelligent study will make you proficient. **Can you qualify** NOW? **Are you proficient?** Can you send and receive when your country calls you?

THE "ELECTRO" CODOPHONE
(Patents Pending)

which we present herewith is the outcome of several months of intense study and experimentation of our Mr. H. Gernsback. It supersedes our former Radiotone Codegraph, which comprised a **Radiotone silent Buzzer, a loud talking telephone receiver** and **a key.** As in all of his work Mr. Gernsback strives for simplicity. So he combined the three above mentioned instruments with one stroke into **ONE** single instrument. He combined the Radiotone Buzzer and the loud talking receiver into a single unit, not only mechanically, **but electrically as well.** This involves **an entirely new principle,** never before attempted, and on which basic patents are now pending.

$1.35

What this remarkable instrument is and does.

The "Electro" **Codophone** is positively the only instrument made that will imitate a 500 cycle note exactly as heard in a Wireless receiver, so closely and so wonderfully clear, that Radio operators gasp in astonishment when they first hear it. And you need no receivers over the ears to hear the imitation singing spark, which sounds for all the world like a high-pitched distant powerful Radio Station. No, the loud-talking receiver equipped with a horn, talks so loud that **you can hear the sound all over the room,** even if there is a lot of other noise.

THAT'S NOT ALL. By lessening or tightening the receiver cap, a tone from the lowest, softest quality, up to the loudest and highest screaming sound can be had in a few seconds.

FURTHERMORE, this jack-of-all-trades marvel, can be changed instantly into our famous silent Radiotone test buzzer, simply by replacing the metal diaphragm with a felt disc, **which we furnish with every instrument.**

FOR INTERCOMMUNICATION. Using two dry cells for each instrument, two **Codophones** when connected with one wire and return ground, can be used for intercommunication between two houses one-half mile apart. Any one station can call the other, no switches, no other appliances required. No call bell either, the loud-talking phone takes care of this.

AS AN ARMY TYPE BUZZER. Last, but not least, **two Codophones** with two 75 ohm receivers can be used to converse **over miles** of fine (No. 36 B & S Wire), so fine that no one can see the wire. Or you can use a long metallic fence and the ground, or you can communicate **over your 110 volt line up to several miles, using no wires, only the ground.**

Full directions how to do all this furnished with each instrument.

One outfit alone replaces the old-fashioned learner's telegraph set, consisting of key and sounder, which is all right to learn the telegraph code but not the wireless codes.

The "Electro" **Codophone** is a handsome, well made instrument, fool proof, and built for hard work. Contacts are of hard silver ⅛ inch in diameter, that will outlast the instrument. Base and housing is of metal throughout, horn and key lever nickel plated and buffed. Three new style metal binding posts are furnished.

There is also a neat code chart and full directions **enabling any intelligent young man or girl to learn the codes within 30 days,** practising one-half hour a day.

Sizes: 6¾ x 3 x 2⅝". Shipping weight, 4 lbs. **$1.35**

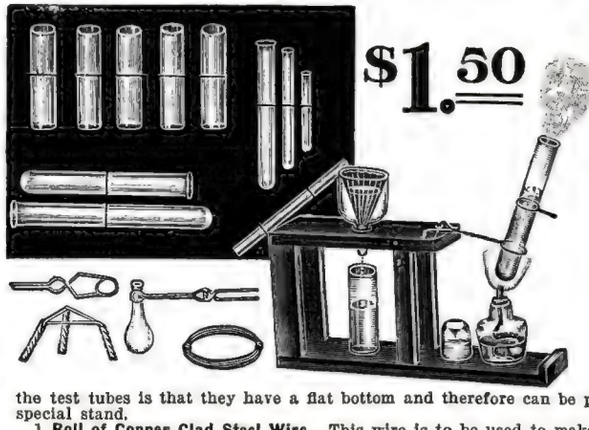
The "Electro" Codophone as described, complete

Money refunded if instrument is not as represented or does not come up fully to expectation.

Ready for delivery July 25th. There will be an enormous demand for this new marvel—place your order now. All orders filled in rotation. Better order two instruments today.

LABORATORY OUTFIT!

How often have you wished to possess a compact outfit in your laboratory combining a **Filter-stand** with a **Test-tube holder** and **Spirit lamp?**



$1.50

We have spent considerable time to combine just such a practical outfit and present it herewith to our friends.

The outfit is complete as per illustration and consists of:

1 Stand, made of well quartered oak, varnished three times, so as to be acid proof and grooved on top and bottom, so that it will not warp in getting wet. Size 5¾ inches high by 11½ inches long.

1 Glass Spirit Lamp. Size 3½ inches by 2 inches. Uses wood alcohol and is invaluable to the experimenter. Besides being used to heat test-tubes contents as per illustration, it can be used to bend glass rods and tubings, to solder wire, etc.

1 Glass Filter Funnel. This funnel is made of heavy glass that will not break easily. It fits accurately in the hole on top of the Filter stand and is provided with a thick rim on the outlet, so that a rubber hose can be attached to it, without slipping off.

1 Glass Rod, to be used in stirring and mixing.

10 Test Tubes, made from the best imported glass. A new feature of some of the test tubes is that they have a flat bottom and therefore can be placed on any table if desired, needing no special stand.

1 Roll of Copper Clad Steel Wire. This wire is to be used to make a number of useful articles as shown in the illustration, such as test-tube holders, tripods to support retorts, etc. We furnish a blue print with the outfit, showing how to make all these wire articles.

Now this whole outfit as described costs you only.....$1.50
Postage extra. Shipping weight, 4 lbs.

Order one today, even if you don't need it now.

We have only 500 outfits on hand, and as some of the glassware is imported, it will be impossible to make up more during the present war. **First come, first served. Money returned if sold out. Send for it today.**

"Electro" Pony Receiver

Our Pony receiver is without doubt the best article for the money to-day.

Points of superiority: Hard rubber composition shell beautifully polished. Powerful permanent steel magnet, soft iron core, fibre coil heads, very thin diaphragm, brass posts **inside.** Hanger can be unscrewed and receiver will then fit our No. AX8077 headbands.

No. EK 1024

SOME USES. —

For all telephone work. Also for making the small testing outfits for repair men in circuit with only one dry cell or flashlight battery. It can also be used for wireless though its low resistance won't permit of such good results as a higher resistance phone.

This receiver is single pole; 2¼ x 1⅛ inches; wgt. 4 oz.; resistance, 75 ohms.

IF TWO OF THESE RECEIVERS ARE USED, IT IS POSSIBLE TO SPEAK AT A DISTANCE OF 150 FEET WITHOUT USING BATTERIES, ONE WIRE BEING SUFFICIENT IF GROUND IS USED.

No. EK1024 Pony Receiver, 75 ohms **50c**

IMMEDIMATE SHIPMENTS

THE ELECTRO IMPORTING CO. Manufacturers

NEWS

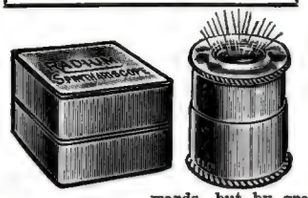
THE "ELECTRO" SPINTHARISCOPE

As usual we lead—others follow. Now the **Spintharis-cope,** first to be introduced to the American public by us. The **Spintharis-cope** was originated by the famous English Radium expert, Sir William Crookes. Everyone knows that Radium gives off a tremendous amount of energy which goes on for several thousand years, with undiminished force.

Radium gives off a number of rays of which the **Alpha rays are known chiefly for their great power.** These electric rays are invisible to the naked eye, the same as are X-rays. But if we take a small amount of Radium and place it in front of a zinc-sulfide screen, the latter lights up. If the radium speck is arranged suitably the Alpha rays will bombard the zinc sulfide with a veritable hail of electrons and the screen begins to scintillate like Fourth of July fireworks.

This is the principle of the **Spintharis-cope,** which we present herewith. It is a little instrument made of two neatly nickeled metal tubes, one

MAKING RADIUM VISIBLE



telescoping into the other. The top tube has a powerful lens. The bottom contains the zinc-sulfide screen and a minute quantity of REAL RADIUM, **too small to do any harm.** The instrument can only be used in the dark. After the top tube with the lens has been adjusted to the right focus, we observe a vividly illuminated green background, glowing in a soft light. As the eye becomes accustomed to it, we begin to see the **ELECTRONIC BOMBARDMENT** of the Alpha rays from the Radium. It looks exactly like tiny fireflies flashing off and on in the dark night. The more we look the better we see the miniature fireworks. We are now in the presence of the most marvelous substance man ever knew, **RADIUM** and its uncanny forces—Radium, which some day will turn the world upside down.

The **Spintharis-cope** up to now sold from $10.00 upwards, but by greatly simplifying it the cost has been brought down by us to such a nominal figure, that no one can afford to be without this most important and marvelous instrument.

You owe it to yourself to own one. It is small enough to be put into your vest-pocket, and interesting enough to show it to all of your friends. **It will continue to operate after you are dead 2500 years!** We guarantee the instrument to be genuine and to contain a minute quantity of **real Radium salts.** "Electro" Spintharis-cope, in neat box and directions for use, as described..... **$1.00**

Sent Prepaid. **IMMEDIATE SHIPMENTS.**

BOYS!

Here Are the Stars and Stripes in All Their Glory.

Be the first one in your town to wear this patriotic emblem. Think of it: An electrically illuminated boutonnière worn in the lapel hole of your coat. It illuminates our National Flag in the original colors with a brilliant electric light. Just insert Flag in buttonhole of your coat, put flashlight case in vest or coat pocket and every time you press the button, the flag in your button-hole flashes up with a beautiful color effect.

Illuminated flag, cord and **plug** (to be connected to any 2 cell flash-light) **60c**

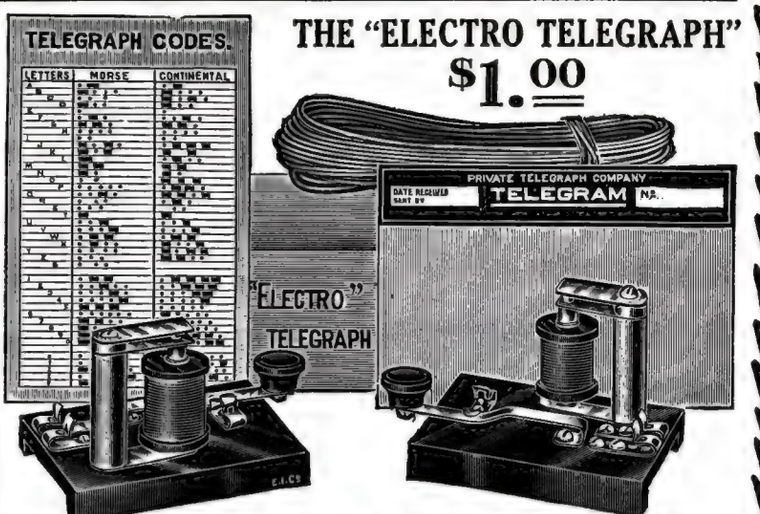
(Postage 10 cents.)

Illuminated flag, flashlight case and **battery, cord** and **plug,** complete as per illustration, **$1.10;** postage 15c.

DEALERS: Write for our proposition today.

IMMEDIATE SHIPMENTS

THE "ELECTRO TELEGRAPH" $1.00

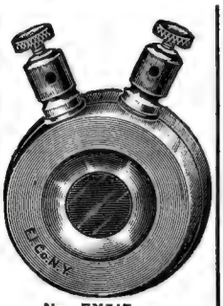


is not a toy, but a practical, honestly built telegraph outfit, which not only sounds but works like the big commercial instruments. By studying the code for 30 days you can become a first-class telegraph operator. Such operators are in big demand now. Outfit consists of TWO complete telegraph instruments each measuring 3½ x 2½ x 2¼. All metal parts are highly nickel plated, including key lever. Note hard rubber knob. Telegraph Code Chart, telegraph blanks and connecting wire comes with set, but no batteries. Outfit works on 2 dry cells (one cell for each instrument). The "Electro" is the ONLY Outfit that works both ways, each station can call; no switches, no extras. Nothing to get out of order. Guaranteed to please you or money back.

Price Complete as Illustrated..... $1.00

At all good dealers and department stores. If your dealer cannot supply you send us $1.00 for outfit and add mailing charges for two pounds, otherwise we ship express collect.

Selenium Cells



No. FX517

Everybody has read about the experiments of telephotography (sending photographs over a wire hundreds of miles) made by Professor Korn and others. It is also known that if the problem of television is ever solved, the selenium cell will play an important role. At present we are the only concern in the United States selling these cells. They are the most sensitive ones made.

Better send for a cell today and try making an electric dog that will follow a lamp, or an electric burglar alarm. It's very instructive and great fun. (See November, 1916, issue **"Electrical Experimenter."**)

No. FX517 Selenium Cell, each..... $6.00

Shipping Weight, 4 oz.

IMMEDIATE SHIPMENTS

"The Livest Catalog in America"

Our big, new electrical cyclopedia No. 18 is waiting for you. Positively the most complete Wireless and electrical catalog in print today. 200 Big Pages, 600 illustrations, 500 instruments and apparatus, etc. Big **"Treatise on Wireless Telegraphy."** 20 FREE coupons for our 160-page FREE Wireless Course in 20 lessons. FREE Cyclopedia No. 18 measures 7x5¼". Weight ½ lb. Beautiful stiff covers.

"THE LIVEST CATALOG IN AMERICA"

Now before you turn this page write your name and address on margin below, cut or tear out, enclose 6 cts. stamps to cover mail charges, and the Cyclopedia is yours by return mail.

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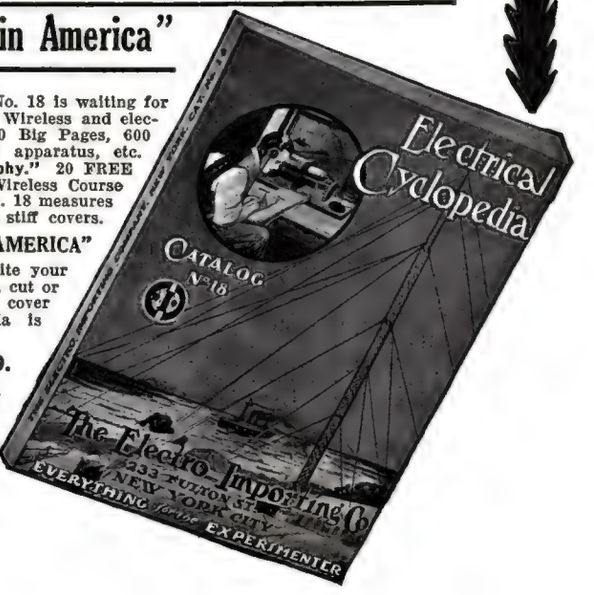


231 FULTON ST., NEW YORK, N.Y.

Details of a 20,000 Meter Undamped Radio Receiver

By WM. BURNETT, JR.

A GREAT deal has been accomplished in the last few years in the reception of undamped wave trains. In this description I will endeavor to relate some details of the experimental work that has been successfully carried on at our laboratory. A great deal of the apparatus ordinarily involved in this work is rather expensive, and unless the person has a good knowledge of electrical laws he is quite apt to get poor results.

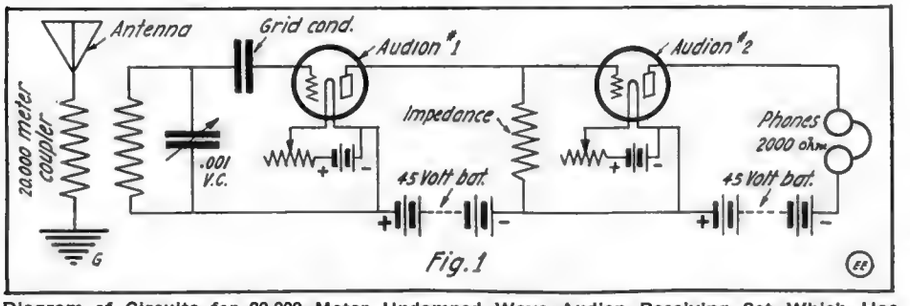


Diagram of Circuits for 20,000 Meter Undamped Wave Audion Receiving Set Which Has Given Highly Satisfactory Results.

The subject of ultra-high frequency currents has set the amateur electrical "bug" afire, and at the present time it is hard to tell from one day to the next just what will turn up in the way of a new invention.

In the accompanying diagram (Fig. 1) is shown a very good set of connections for the reception of long undamped waves. This consists of very few pieces of apparatus and works admirably well. Any one who has access to two Audion (round or tubular) bulbs will find that this is one of the most simple hook-ups.

These connections give a very sensitive circuit and by spending a little time in adjusting the Audions the experimenter will find it possible to attain excellent results. It is advisable not to connect a variable condenser across the 'phone terminals, as this paralyzes them to such an extent that the diaframs refuse to move. The impedance which is connected in the diagram is one of about 9,000 ohms; a ½" spark coil secondary, having an iron wire core running thru it, will answer the purpose.

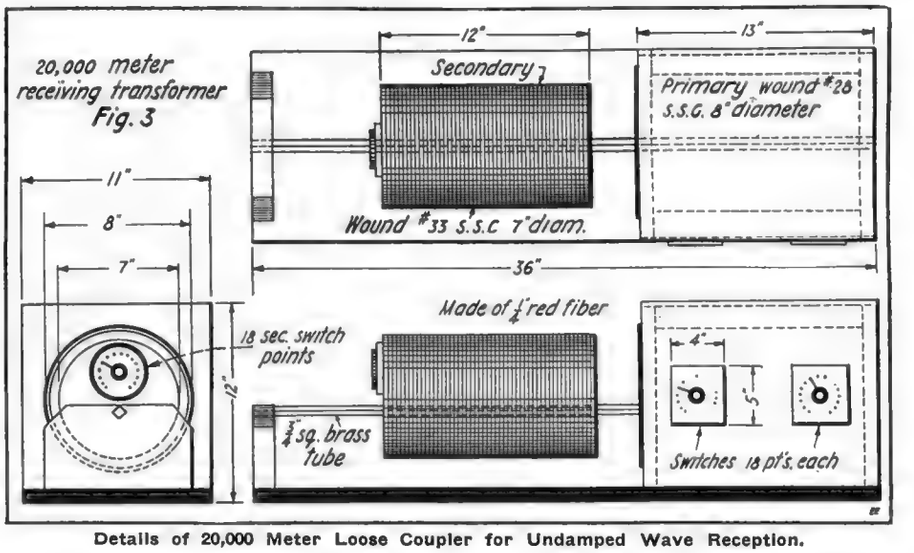
This hook-up produces a very strong regenerative effect. This can be partly done away with if the proper attention is paid to the adjusting of the filament rheostats. In regard to the resistance of the 'phones, I am convinced that the 2,000 ohm type will work better than the 3,000 ohm type. The usual care should be taken in connecting the filament of the bulb to the negative binding post of the lighting battery and the rheostat to the positive post of the lighting battery. However, all who have had experience with the Audion, know that the characteristics of the bulbs differ and the experimenter will be able to adjust these minor difficulties by using good judgment.

The loose coupler used in this hook-up is one built after the so-called Cambridge Receiving Transformer design. Its overall length is 36 inches and the secondary slides on a ¾" square brass tube. (Fig. 3.)

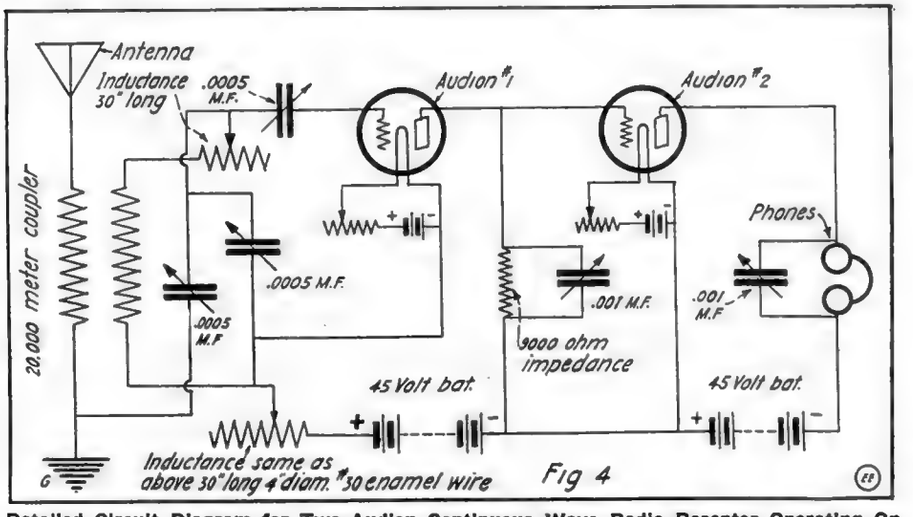
The primary is 12" long and 8" in diameter, wound full of No. 28 single silk covered copper wire, and is divided into 19 equal parts. Being of the Navy type, the first 18 taps are brought out to switch points and the remaining section is divided into 19 equal parts and these brought out to as many switch points. The accompanying illustration (Fig. 2) will explain this.

Rather than count the turns, wait until after winding and then by direct measurement locate the position of the taps. The secondary is 12" long and 7" in diameter and is wound full of No. 33 S. S. C. wire and divided into 19 equal sections and brought out to the switch points on the front of the secondary. As the drawing below is self-explanatory, giving the principal dimensions, no further space will be given to the construction of the receiving transformer.

My best results have been obtained with the following set of connections: (See Fig. 4.) The loading coils or inductances are 4" in diameter and 32" long. These are wound with No. 30 enameled magnet wire. Taps are taken off at 10 different places, thereby giving a great variation of in-



Details of 20,000 Meter Loose Coupler for Undamped Wave Reception.



Detailed Circuit Diagram for Two-Audion Continuous Wave Radio Receptor Operating On the "Heterodyne" Principle.

USEFUL HINTS ON THE AUDION.

By Frank J. Collins.

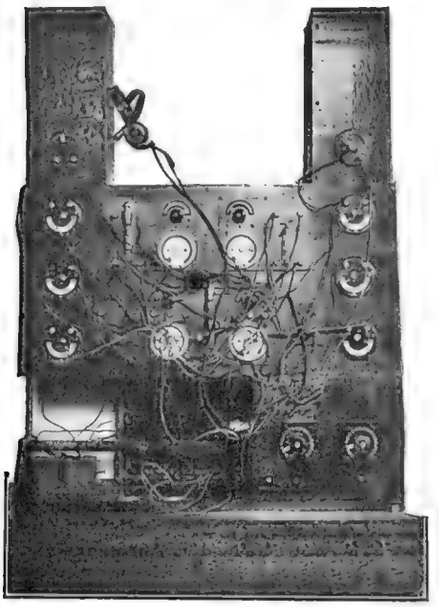
IN this paper an attempt will be made to clear up certain misunderstandings current among numerous amateurs in regard to the required amount of apparatus employed in the Armstrong Regenerative Audion receiving circuits.

Numerous articles have appeared in past issues of electrical magazines, to the effect that the Grid and Wing coils are unnecessary; that certain condensers could be eliminated; that the body could not approach the apparatus without affecting the tuning considerably (due to the capacity of the operator's body) and that the oscillations were unsteady, to say the least.

There were furnished with these articles, "newly discovered" hook-ups by the authors, claimed to do the same thing as the Armstrong arrangement, employing the minimum of apparatus and giving the same results!

(*Continued on opposite page.*)

ductance. An advanced form of the Armstrong regenerative circuit is used and is here given for *Amateur* use only.



The Complete 20,000 Meter Audion Receptor for Undamped Waves, With Loading Inductances and Large Loose Coupler.

Large values of inductance and small values of capacity give the best results. N.A.A., W.L.S. and N.A.J. have been heard 40 feet from the 'phones. Two pairs of 3,000 ohm 'phones work very well in place of the one pair of 2,000 ohm. The antenna from which this set is operated is 100 feet high and 100 feet long, of the "T" type.

USEFUL HINTS ON THE AUDION.

(*Continued from opposite page*)

In the first place, the Grid inductance not only acts as a wave length tuning inductance, but also as a storage of energy. This stored-up energy discharges back into the Wing inductance (which also acts as a storage of energy). The Wing inductance transferring the energy back again into the Grid circuit, causing a greater amount of current to flow, than would ordinarily occur in the absence of these inductance coils, and therefore, a greater drop of current across the telephones upon the reception of signals.

It is impossible to obtain maximum signal strength, or to hold the oscillations steady, for the reception of undamped waves, unless these coils are employed and adjusted properly.

The complaint that the body cannot be brought near the apparatus during the reception of signals without interferring with the signals, can be overcome to a large degree by grounding the Grid circuit between the secondary of the loose-coupler and the negative side of the telephone battery, also by short-circuiting the unused or idle turns on the Grid and Wing inductance coils, and also by grounding the headband thru a small condenser..

These precautions will enable the operator to work the arrangement with little or no trouble from capacity effects.

Instead of using long coils, 30 to 40 inches in length, four tubes of 6-5½-5 and 4½ inches respectively in diameter, and 8 inches long may be wound full with number 32 S.S.C. magnet wire and placed within one another, using insulating rings to separate the windings, taking care the windings do not oppose one another. This arrangement of coils will work the same as the longer coils and take up far less room.

The use of extremely large loose-couplers for long waves is not necessary. The mutual inductance between primary and secondary of such large couplers is very great and when used in conjunction with the Armstrong circuits requires very long (or loose) coupling. An air space of 8 and 10 inches between primary and secondary is not uncommon.

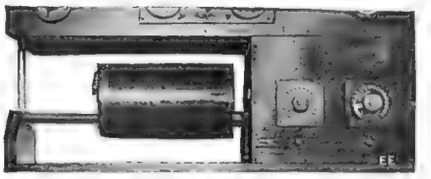
Practically the same results will be obtained on a much smaller coupler, giving smaller coupling between primary and secondary; the signal strength and tuning properties remaining the same as for the larger coupler.

It has been stated that one should never use finer wire on the primary of the loose-coupler and the primary loading coil than number 24. That is all right theoretically and in the reception of shorter wave lengths, but in dealing with undamped wave lengths the frequency is much lower, the current penetrating further into the wire.

Number 32 wire is found from experience to give practically the same results as number 24 wire, when used as primary loading inductances in receiving long waves, besides requiring a minimum of space.

While it is admitted the high frequency currents travel on the surface of the wire and granting the surface of a number 32 wire is not as great as a number 24; in practise, the same signal strength will be obtained and the sharpness of tuning is not affected by the finer wire.

There is no necessity of building receiving transformers for the reception of wave lengths in excess of 12,000 meters, as there are few stations at the present time using wave lengths above that value (12,000 meters).



Close View of 20,000 Meter Loose Coupler. Primary, Control Switches at Right; Secondary Coil at Left.

A variable condenser should not be shunted across the primary inductances for tuning in the long wave-lengths, but a variometer employed instead, as it is well known, a condenser so used, decreases the current strength of received signals conconsiderably. (Dr. Cohen.)

That a short antenna is suitable for the reception of long wave undamped signals is quite true, but all things remaining the same, the higher and longer the antenna, the stronger the received signal, providing the fundamental wave length of the antenna remains below that of the received wave. The above assertion holds true in all cases.

Finally, every piece of apparatus as used in the Armstrong circuits is absolutely necessary and the elimination of any one piece of apparatus *decreases* the efficiency of the set proportionally.

There is only one fault to find in connection with the working of the apparatus, and that is the unexperienced amateur who condemns it before learning how to work it.

There is no doubt but what it requires experience to do real, serious long-distance work, and the trouble lies mostly in the inability of the amateur and not in the apparatus, if connected properly.

The apparatus should consist of a primary loading inductance; a loose-coupler—Grid and Wing inductance; Grid condenser; secondary tuning condenser; Wing coil condenser, and telephone condenser, in conjunction with the regular Audion detector apparatus.

In conclusion, the long tubular bulb with the filament entirely surounded by the Grid and Wing, will give better results for the reception of undamped waves than the ordinary round form, as it is more stable in operation.

HOW TO EXTINGUISH ELECTRIC FIRES.

In the extinguishing of electrical fires there is large opportunity for the display of good judgment and prompt action. The element of time is exceedingly important. The operator should observe whether conditions warrant the cutting of current from affected part before the fire is attacked. His knowledge of the apparatus under his charge should be such as to guide him promptly, says H. L. Ganett in *E. D. & C.*

Sand and powder bicarbonat of soda have been found to have some merit as extinguishing agents in certain kinds of electrical fires, but their use is limited.

Where sand is provided for fire-extinguishing purposes, it should be carefully sifted thru a sieve of window screen of 14 mesh to remove the larger particles, especially scraps of metal. It should be kept in a clean and dry condition and should not be used where there is a liability of its getting into the bearings of moving parts.

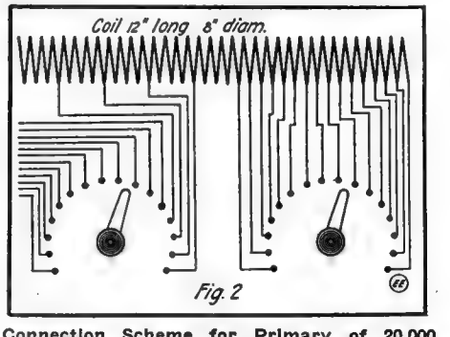
In tests recently made in extinguishing oil fires, wet sawdust impregnated with sal ammoniac has been found to have considerable merit.

Carbon tetrachlorid has shown up well as an extinguishing fluid and has the advantage of being a non-conductor to a high degree, which is a very valuable attribute.

In many modern plants the liability of structural fires is vastly less than the liability of the occurrence of fire in apparatus, and much of this apparatus is so constructed that in case of fire occurring in the interior it is very difficult or impossible to use an extinguishing agent with success

CONTROL BY SOUND.

At Lady Drogheda's Aircraft Exhibition at the Grafton Galleries, an interesting model airship constructed by Lieut. Roberts, in which the control is effected by sound, was recently exhibited. Electric circuits are worked by a telephone diafram, and this is tuned by an air column so as to respond to any desired note. On sounding this note the electric



Connection Scheme for Primary of 20,000 Meter Loose Coupler.

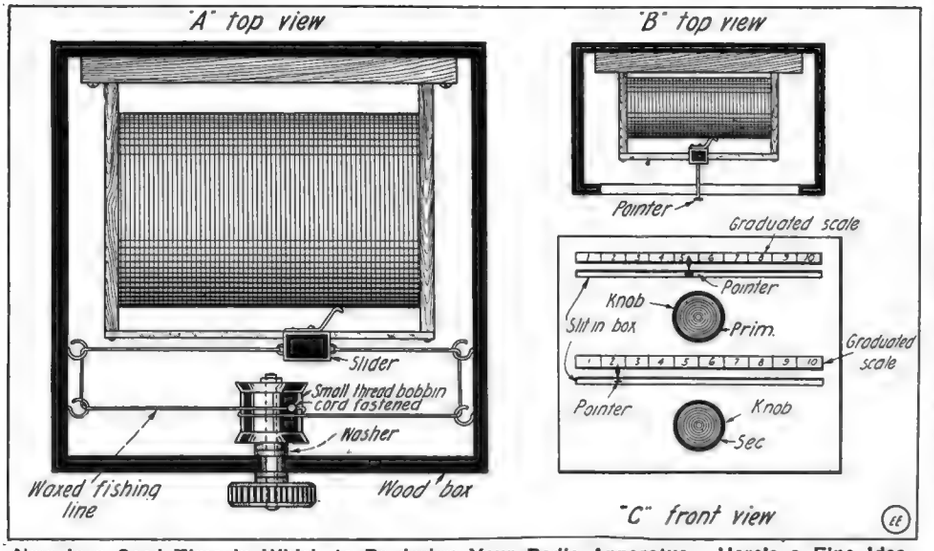
apparatus goes into action, the diafram acting as a relay, and by bringing this relay into action a sufficient number of times any particular motor can be put into operation.

Converting a Tuning Coil into a Cabinet Tuner

By N. H. ALLEN

THE accompanying idea is to convert a one, two or three slide tuning coil into a cabinet tuner with rotary control at small cost.

First, secure a suitable box, similar in size to the tuner and slightly larger as shown in the drawing, and fasten the base



Now Is a Good Time In Which to Re-design Your Radio Apparatus. Here's a Fine Idea for Converting Your Old Tuning Coil into a "Cabinet" Style Set. By Changing Around the Connections a Number of Effective Tuning Arrangements May Be Had.

of the tuning coil to the back of the box. Then fasten four small screw hooks (or better still, use small pulleys) to the box in the position shown in the drawing. A small hole should next be bored in the face of box in order to accommodate the rotary control knob shaft, on the inside end of which is fastened a small thread bobbin. The drawing shows the manner of attaching much better than I could describe it, so I will not go into details, and anyway there are no two amateurs that would do it just alike. When knob, bobbin and screw hooks are all in position, a waxed piece of fish-line is fastened to the slider, run thru the hooks round the bobbin once or twice and fastened securely. Thus it will be seen that when the knob on the front of the cabinet is rotated the slider will run along the coil to any desired position. (A good way to fasten the fish-line to slider is to drop a piece of melted wax, such as used in sealing batteries, on the line and slider, effectively holding it in place and which does not injure the slider in any way.)

Next refer to figure B, in which the apparatus described above is left out for clearness and the next point will now be described. This consists in the pinching of the minute hand from an old clock or making one from tin or brass. Fasten it to the slider in the manner described above for fastening the cord in place. The end of the pointer is bent in the manner shown so as to project thru a slit in the face of the box, cut the same length as the slider rod. (This is clearly shown in Fig. C.) Looking at C, it will be seen that a graduated scale is tacked or glued to the front of box just above the slit. This scale may be graduated in any manner desired.

If a two or three slide tuner is used, simply duplicate the operations described heretofore. The completed two-slide tuner is shown in C.

Now for the climax. When knobs are moved the pointer will be moved along the graduated scale and show the position of the slider for any operation. If a two slide tuner is used, the top knob may be marked *Primary* and the bottom one *Secondary*. The whole of the box, except scales, may be varnished for good appearance.

If a chart be prepared as shown here, the operator will be able to immediately adjust his tuner for listening in to any desired station. Thus if (9XE) is found to come in loudest when Prim. pointer is at 7½ and when Sec. Pointer at 3¾ by arranging as shown below, when the operator wishes to listen to (9XE), he simply adjusts his tuner accordingly; no guess work being necessary.

Name of Operator	Operator's Address	Oper's Call Signal	Adjust. for Pri.	Adjust. for Sec.
H. SMITH	323 Oswego St. New Jersey	GEE	7.8	5.1
J. GIBSON	18 St. Paul St. New York City	WIZ	9.8	7.3

EFFECT OF WATER VAPOR ON THE PROPAGATION OF ELECTROMAGNETIC WAVES.

An interesting paper on this subject by Dr. Frederick Schwers, was recently presented before the Physical Society of London.

The author discusses the probable influence of moisture in the atmosphere on the refraction of electromagnetic waves round the earth's surface. The conclusion of Kiebitz that the presence of moisture does not affect the dielectric constant by more than 10 per cent. is shown to be erroneous, being based on the assumption that the Clausius-Mossoti formula, $\frac{k-1}{k+2}\frac{1}{d}$ = constant, holds when passing from the liquid to the gaseous state. Examples are quoted to show that this law fails in many cases, especially where the dielectric constant is high in the liquid state.

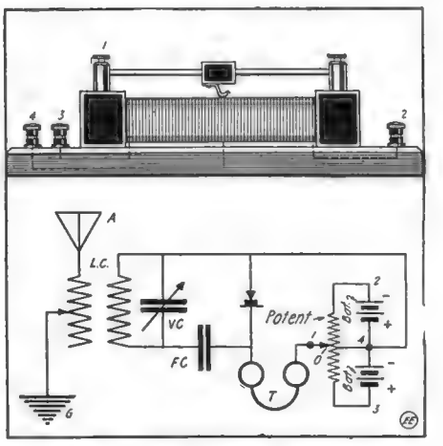
In the absence of more accurate data for ordinary temperatures, the author prefers to assume a value for the dielectric constant of water vapor obtained by extrapolating the results obtained by Baedeker for higher temperatures. The extrapolated value is almost certainly too low.

From this result, and the average conditions of the atmosphere over the ocean with regard to temperature gradient, etc., deduced from meteorological data, it is shown that the lowest layers of the atmosphere (1,000 to 1,500 meters approximately in depth) refract electromagnetic waves towards the earth, so that the greater part of the space waves will reach the receiver, contrary to the conclusion of Kiebitz.

Dr. C. Chree in discussion, says:—The author, presumably unaware of their existence, does not refer to the somewhat numerous upper air data which have been publisht in this country (England) by the Meteorological Office. A study of this data as to the temperature gradients would, I think, have proved useful. Inversions are not confined to the lowest layers, but in these layers they are exceptional, and do not suffice to reduce the average temperature gradient to such low values as the author has taken for the first and second kilometers. For these, 5 deg. or 6 deg. per kilometer would not have been too high, especially for tropical regions. If the empirical exponential formula for vapor pressure be assumed, the pressure at any given height varies directly with that at ground level, and so in temperate latitudes is much lower in winter than in summer. It thus seems rather a fundamental point whether wireless phenomena in temperate latitudes show a marked annual variation corresponding with that of vapor pressure at ground level.

A DUPLEX POLARITY POTENTIOMETER.

By the diagram given it will be noticed that two batteries are employed instead of the one battery formerly employed with the potentiometer; this by no means changes the ordinary hook-up, and while serving for the same purpose as usual, eliminates the continual shifting of battery or detector leads when inserting either one, in order to find the correct connection. I have found that this connection works very good, especially when experimenting as most amateurs do; i.e., continually changing detectors and circuits. When the slider is at the middle of the potentiometer the instrument is cut out of the circuit and a change either from positive to negative is made possible by moving the slider either above or below the point marked O, thereby making it unnecessary to shift detector or battery leads in order to get the correct polarity. Your old potentiometer is easily converted for this circuit by taking off a lead from the center of the grafite rod or coil.



By Means of the Duplex Potentiometer Scheme Shown, It Is Possible to Quickly Reverse the Battery Current Thru the Detector or Other Device.

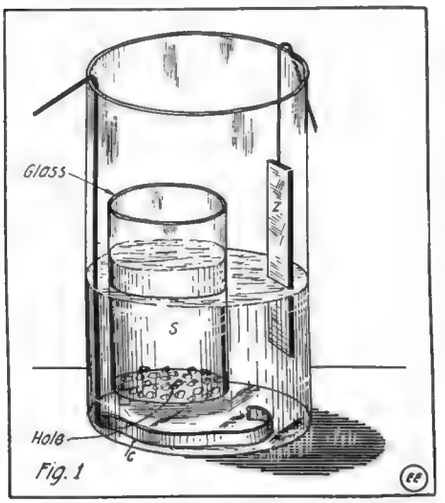
Contributed by EDW. T. JONES.

THE CONSTRUCTOR

"Bats"

By THOMAS REED

"BATS" in this case is short for batteries. All those who expected a nature-fake story, or a treatise on the kind of bats which unkind people say inhabit the belfries of electrical experimenters, may now pass out quietly thru the door on the extreme left. And please don't slam it!



"One of My First Attempts In Battery Research," Relates the Author, "Took the Form of a Modified Gravity Cell In which I Tried to Control the Action of the Copper Sulfate By Means of a Small Hole In Its Glass Retainer 'S.'"

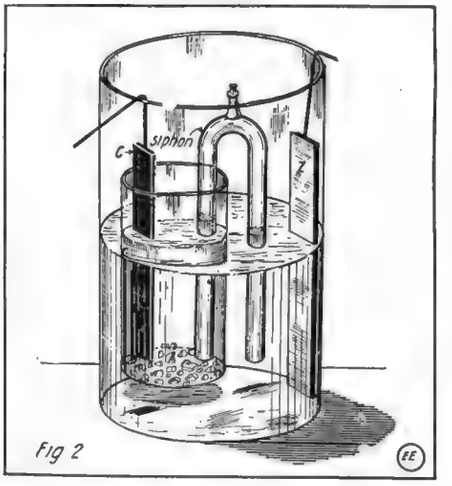
The old house where I lived and moved and had my shop hadn't been wired for electricity when it was built. You see, at that time builders were quite conservative about including electric fixtures in the specifications, because the only lighting current in existence was being produced in laboratories at a cost of about a hundred dollars per kilowatt-hour. In fact, electricity was in its infancy; and if you know anything about infancy you'll recognize that its expense-bill was running true to form.

By the time I began to take notice, electric lighting had conquered the streets and had begun to invade the houses. It was useful mostly as one of those modest means of advertising that you were "well off," same as the cast-iron hound on the front lawn. If you succeeded in blowing yourself like this without the grocer getting uneasy about his overdue bill, the inference was that you and Want were strangers, and that the mortgage had been left on the domicile simply in a public-spirited effort to keep money in circulation. As mere illumination the light was negligible, burning at various low degrees of candle-power, and usually going out whenever the neighbors dropt in to admire it.

I speak thus bitterly of the early light because it was an unsatisfied hankering of mine to have this current on tap for the operation of the various electrical machines which my young factory turned out with regularity. The Fates said me nix on that, and I defied them as one must; but it peeves me that now in my flat, when I can have all the "juice" I feel like paying for—I haven't any shop! Fates are like that: if they conclude to hand you the thing you've wished for, they wrap up with it a neat kibosh to prevent any enjoyment of it. It's just when the fish are biting fit to take your leg off, that your bait gives out, now isn't it?

However, you know we old fellows are great for finding reasons why any given calamity was "all for the best," and I can console myself for the lack of the piped lightning in this way: if I'd had the handy electric socket and one of those dinky toy transformers they sell in these days (which consume me with envy just as a great big shut-eye doll with real hair consumes a girl of any age from 9 to 90) I should have mist the pleasure of experimenting with batteries.

The question of operating current was always with me, butting in like the traditional hag among the good fairies at the christening of every new rinktum, with the threat of stunting its career thru malnutrition. To provide my scientific family with



When the Valve Action Shown In Fig. 1, Did Not Seem Very Promising, the Author Tried Out a "Siphon" for Controlling the Flow of the Copper Sulfate Solution, which Is a New One On Us.

their daily ration of wattage was a grim, endless duty; so, more from necessity than inclination, I was continually fussing with batteries.

The first battery I ever saw was the one used to actuate the family medical coil. It was a zinc cylinder suspended in a copper can, using a "straight" blue-vitriol solution as an electrolyte. In action, it bubbled and boiled, and produced whiskers on the zinc and mud on the bottom with surprising industry. It would run the coil for about half an hour, after which you had to clean it, and after that, clean yourself; so take it all together the coil gave you a lot of exercise as well as faradic effects. Father used it mostly to relieve his insomnia; after the thing was all packed away again, and he'd had his bath, he could usually sleep quite well. Electricity is life!

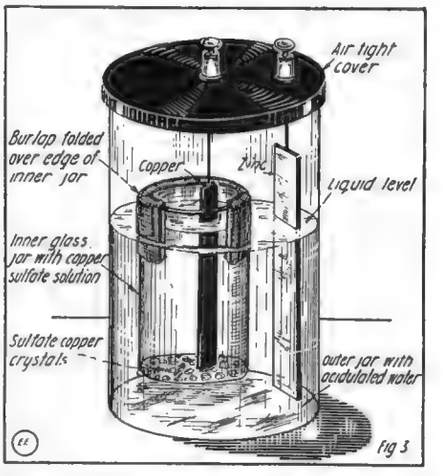
That mud-battery was the one I used on my first sounder, the one with the gate-hinge for an armature. It was quite strong while going at its proper stride, though not much stronger than the gate-hinge demanded. But when father's reserve stock of blue vit. solution was all used up, and I had duly received my "talking-to" for diverting it from its beneficent mission of nerve-relief, I saw distinctly that it was too rich for my blood. It was related to my own finances in about the ratio that three chorus-girls and a spendthrift son would bear to an elderly bookkeeper.

The flower of Bughood would have frozen in the bud but for good Père Leclanché. You remember Leclanché's original wet cell—nothing could have fitted better the wants and the pocketbook of the struggling Bug. I wish all the wattage that the old wet cells ever produced could be collected and burned in a neon lamp as big as a barrel in honor of that benefactor of the race of boys!

You could make a Leclanché cell for as near nothing as figures will come without lying. Any old cut-off bottle would do for a jar. For the porous cup we used a canvas bag. For a nickel the junkman would part with a large piece of second-hand sheet zinc; sal ammoniac and black oxid of manganese were the only cheap goods in the drugstore. For the carbon we made a raid on the gas works, where the rounded scales from the retorts were thrown out in heaps, there being no use for them in those days. Gee, but that carbon was hard! It was impossible to saw or work it in any way. To secure plates, we would shatter up a big hunk and select from the resulting hunklets such as happened to occur somewhere near the desired size.

A battery made in this way, with the jagged end of the carbon protruding from

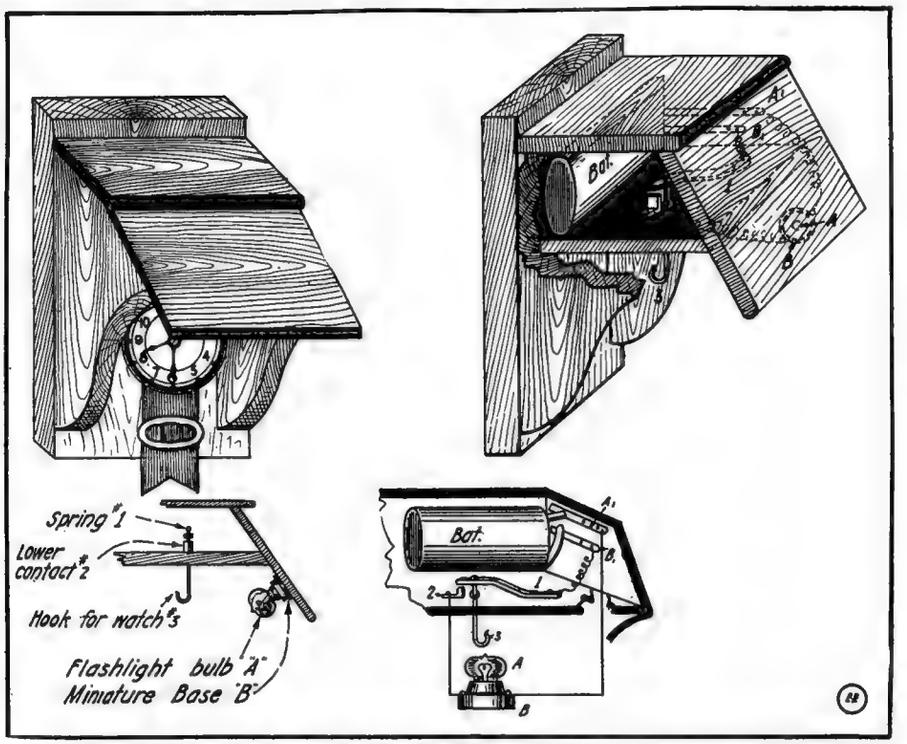
(*Continued on page 282*)



Finally the Gravity Cell Research Work Boiled Down to the Type Shown. The Copper Sulfate Oozed Out By Capillarity Thru Several Layers of Burlap Dipping In Both Solutions.

An Ingenious Battery Night Lamp

I describe herewith what I call a *night light*. It is fastened to the wall near the bed and when I wish to know the time I just give a slight pull on the watch fob and can tell the time by the light of the miniature bulb. In the drawing the battery terminals make contact with brass or copper strips, A_1 and B_1. The reason for this is so battery is easier to change in renewing than it would be if wires were soldered direct to them.



Do You Keep Your Watch Beside the Bed At Night? Here's a Nifty Battery and Lamp Attachment Which Enables One to Light the Dial by Simply Pulling on the Fob or Chain.

Contributed by J. A. SIMONIS.

MINIATURE ELECTRIC LIGHTS FROM 110 VOLT LAMP.

To do the following "stunt" will require quite some patience, so don't get discouraged if it does not pan out well at first. Procure a few burned-out 110-volt Mazda lamps, say from 10 to 15 watts, and shake or jar a bulb until all the wires are broken loose from the supports or the frame to which the fine wires are attached. Now turn the bulb so that the heavy end is pointing down and get all the broken pieces of wire on the side of the bulb where the current enters. Quickly invert the bulb and some of the wires may fall across the lead in wires—or they may not. If they do not, try it over again. When you get a wire or two to hang, connect a small current to the lamp and you will have a light, and a cheap one too. I generally connect a flashlight battery at first, in order to weld the small wires firmly in place, and then by means of a transformer and rheostat, adjust the current until the lamp burns at full brightness. I have obtained as much as 32 C. P. from nine volts on such a lamp.

Contributed by EARL MELDRIM.

HOW TO SOLDER ALUMINUM.

In soldering aluminum, it is necessary to bear in mind that upon exposure to the air a slight film of oxid forms over the surface of aluminum, and afterwards protects the metal. The oxid is the same color as the metal, so that it cannot easily be detected. The idea in soldering it is to get underneath this oxid while the surface is covered with molten solder.

First:—Clean all dirt and grease off the surface of the metal with a little benzine [bearing in mind that benzine forms an explosive mixture when in contact with air, and for that reason should not be kept near any flame whatsoever].

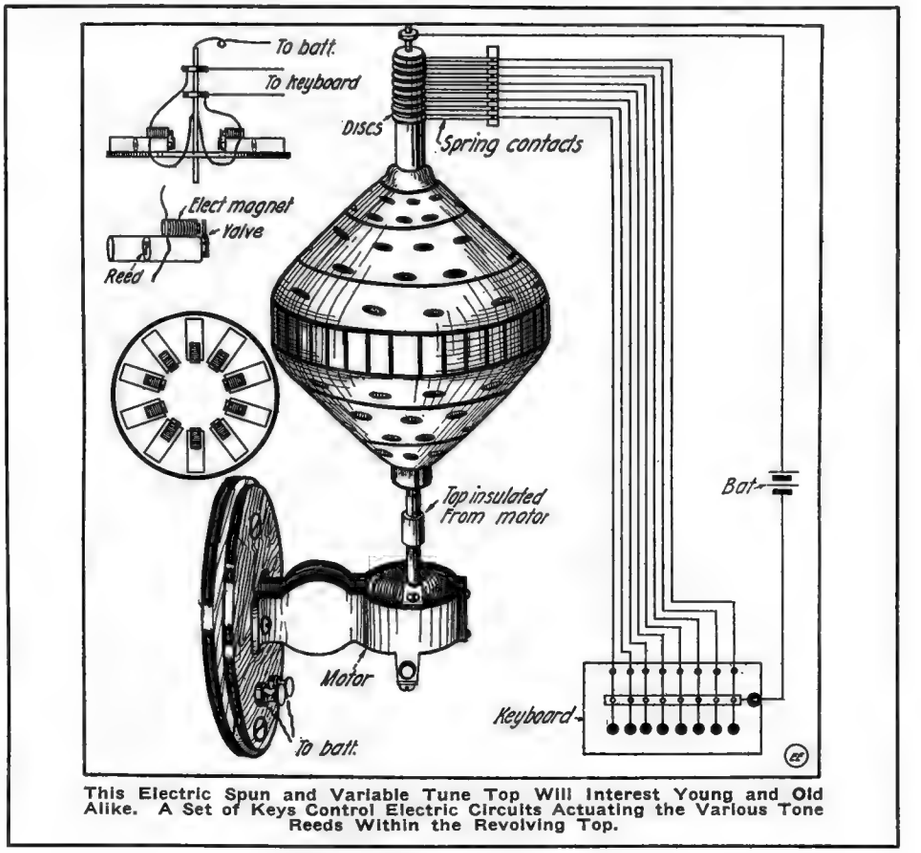
Second:—Apply the solder with a copper bit, and when the molten solder is covering the surface of the metal, scratch thru the solder with a small wire scratch brush. By this means you break up the oxid on the surface of the metal, underneath the soldering, and the solder, containing its own flux, takes up the oxid and enables you, so to speak, to *tin* the surface of the aluminum.

Contributed by ALBERT W. WILSDON.

AN ELECTRICAL MUSICAL TOP.

Here is a plan for making an electric top which will play a tune. It consists of a top run by an electric motor. On the inside of the top are placed small tubes, each fitted with a reed of different tone. On the end of each tube is a circuit-breaker which is opened by an electro-magnet. One terminal from each electro-magnet is connected to the rod running thru the top, the other terminal being connected to a small brass disc, insulated from the rod. Each magnet has a separate disc and a small brass spring brush. Each spring is permanently connected with a key on a keyboard. The discs must be separated slightly from each other. In operation, the motor is started, a key is prest on the keyboard, the current passes thru electro-magnet, causing the hole in the end of the tube to open. This permits the air to pass thru, thus causing a suction which vibrates the reed. By having enough reeds to form the musical scale a tune can thus be played. Since the electro-magnets are connected in multiple, more than one note can be produced at a time.

Contributed by EARL FINFROCK.

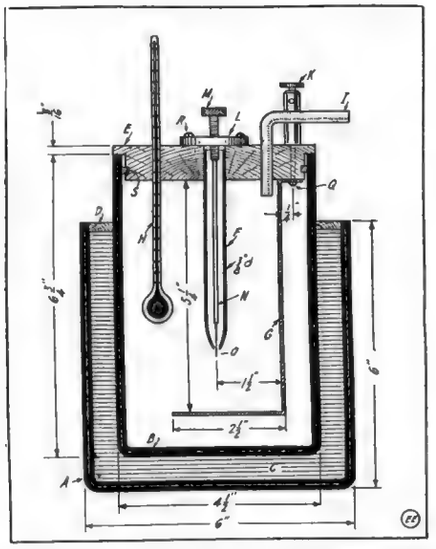


This Electric Spun and Variable Tune Top Will Interest Young and Old Alike. A Set of Keys Control Electric Circuits Actuating the Various Tone Reeds Within the Revolving Top.

An Electrolytic Interrupter for Low Voltages

By C. A. OLDROYD

THE main advantages of the electrolytic interrupter are: Increased number of interruptions per second, increased spark length and intensity and remarkable steadiness of the image when used for X-ray work. The electrolytic interrupter also makes a condenser for the primary of the coil unnecessary: The only draw-back is the necessity of using a voltage of about 110 volts when employing the *usual* type of "Wehnelt" interrupter.



Sectional View of Low Potential Electrolytic Interrupter for Use on Voltages as Low as 12, and Provided with an Adjustable Anode, Thermometer and Special Means for Keeping the Solution Hot.

In the following it will be shown how the interrupter may be modified to work at a potential of only 12 volts, thus enabling the experimenter who has only a storage battery or primary batteries at his disposal, to work his coil with an electrolytic interrupter. The interrupter consists of an inner stoneware jar B, and an outer one A. Both are separated by a layer of cotton-wool C. The inner jar carries a wooden cover E, which fits air-tight into B. This is achieved by using a small rubber band S, in a groove in the cover, the groove having such a depth that the outer diameter of the rubber ring in position is about 1/32 inch larger than the inside diameter of the jar. A very slight pressure will be sufficient to fix the cover E into the jar. From the cover E is suspended a lead plate G, bent as shown. This plate is held in position by the screw Q, of the binding post K. A glass tube F, ⅜" diameter is fitted into the cover E and has a small hole at the lower end to let the platinum wire O pass thru. This wire is attached to a lead rod N, which in turn is fixt to an adjusting screw M. This screw works in a small hard-rubber plate L, which is attached to E, by three wood-screws R. H is a thermometer, reading up to 120 degrees or 150 degrees centigrade; it passes thru a hole in cover E. I, is a small glass tube bent as shown and mounted in the cover E in such a manner that the lower end just projects thru E.

The reader may be puzzled why two containers are used where one would be sufficient, but the reason is that for such low voltages as mentioned above, *i. e.*, 12 volts, the diluted acid in the interrupter must be kept at a temperature of about 90 degrees centigrade to ensure proper working. The layer of cotton-wool C, keeps the heat in the inner vessel B, and once the diluted acid in B is warmed, it will remain warm for several hours. The gases produced by the interrupter can only escape thru the glass tube I, as the cover E fits airtight in B. As the small sketch shows, the tube I is connected by means of rubber tubing to a second glass tube Y, fitting into a stopper Z, both being fixt into a glass bottle containing a solution of water and washing soda, which neutralizes the gases produced by the interrupter when working. The tube Y reaches about 2" below the level of the solution and the stopper Z, has a notch on one side to let the gases escape, after they have past thru the soda solution, and thus been neutralized. To warm the solution in the inner container B, of the interrupter, it is only necessary to withdraw the jar B by gripping it at the projecting part and place it on a radiator or on a gas ring until the thermometer shows about 90 degrees centigrade. Then the container B can easily be replaced into A, in the same way. When warming the solution, care should be taken to do this gradually or the jar may crack.

To build this interrupter let us first procure two stone jars, A and B, which should be approximately of the dimensions given. Place some cotton-wool on the bottom of the outer vessel A and compress it slightly by placing B into A. The thickness of the wad of cotton-wool should be about ½". Now fill the remaining space between A and B with cotton-wool, always compressing it with your fingers. Next cut a small ring D, from wood about ¼" thick, and glue it into A. This ring serves to keep the cotton-wool in position when withdrawing or replacing the inner jar B. Next turn the cover E from hard wood ¾" thick, making the lower part fit easily into B. Cut the groove shown and place a rubber band S into it. As mentioned above the outer diameter of S when in position, should be about 1/32" larger than the inner diameter of the jar B. Drill a hole ⅜" diameter thru the center of the cover for the glass tube F and three other holes T, U and V, as shown in detail drawing of the cover. T is for the thermometer, U for the glass tube I, and V is a clearance hole for the screw Q, of the binding post K. This cover plate must now be soaked in molten paraffin wax for at least half an hour.

We turn now to the glass tube F. This is 4⅜" long by ⅜" diameter. Take a tube about 15" long and heat the middle over a Bunsen burner until the glass becomes fairly soft. Then draw the two ends apart and you will have two glass tubes with tapering ends. Cut the taper where the bore is about ⅛" and smooth it on sand-paper. Now cut off the parallel part of the tube to make the total length 4⅜" and fit the tube into E, by means of shellac varnish. We now come to the adjusting screw: Procure a screw M, with 3/16" thread, by about one inch long; solder to M a piece of lead rod N 3⅝" long by ⅛" diameter and solder to N a platinum wire O. This should be one millimeter diameter by ¾" long. If you have a slightly smaller or larger gage in your possession, you may use it, as the diameter of the wire is of no great importance. The hard rubber plate L, is next made to the dimensions given in the detail drawing, and the center hole is tapt to suit the adjusting screw M. The plate L is then painted with shellac varnish at the side, which is to be in contact with the cover and screwed to E by means of three small screws R. The next part to be completed is the lead plate G. This is made from strip about 1½" wide by 18 gage thick, and bent as shown. G is then fixt in position by screwing Q, into the binding post K. The thermometer H and glass tube I, are now put in place, using again shellace varnish.

The interrupter is now complete and has to be filled with a solution of one part of sulfuric acid in ten parts of water, and stir the water all the time with a glass rod. (Pour acid into water—never water into acid.)

The wash bottle is next made from an eight-ounce glass bottle or any similar size. The glass tube Y is of the same diameter as I, and bent as shown. The stopper L receives a notch as mentioned before. Place some lumps of washing soda into the bottle and pour sufficient water on it to bring the water level about 2" above the end of tube Y. Finally connect I and Y by means of rubber tubing.

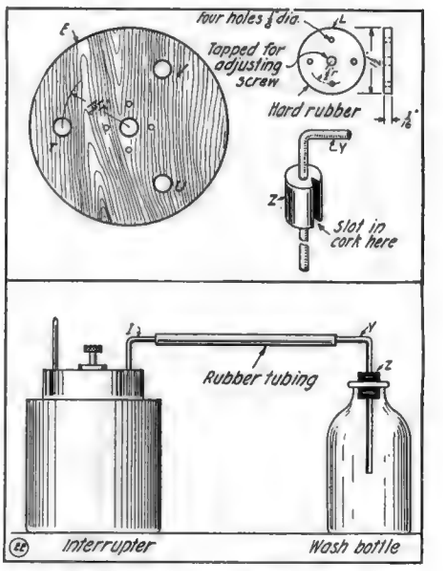
The interrupter is connected in series with the primary of the coil, the lead plate being the cathode. (*A lead sleeve covering a copper wire may be used instead of a lead rod for the anode.*)

HOW TO MAKE FIREPROOF PAPER.

Dip a sheet of paper in a strong solution of alum water, and, after drying it, repeat the process three (3) times; then hold it in a flame and it will not burn.

To melt steel as easily as lead, heat a piece of steel in a fire until it is red, then take it out and touch it with a piece of brimstone (sulfur). As soon as the brimstone touches the steel the metal will melt and drop down like liquid.

Contributed by JAMES MILLEN.



Details of Low Voltage Electrolytic Interrupter and Arrangement of Wash Bottle for Neutralizing the Gas Fumes Produced.

A Hand-Feed Arc for the Experimenter

I give herewith a sketch of an arc lamp of my own design. The right hand binding post is connected to the stationary carbon. The left hand binding post is connected to the hinge F, and is fastened along the wood standard R. By turning the threaded rod A, this causes the slider C, which is not threaded, to lower or raise the brass arm I. (Fig. 1.)

It is best to make all of the parts such as the base and upright R, of slate, fiber, soapstone, marble or other non-combustible material. They may be constructed of sheet iron with a little care as to the insulation, using mica washers and bushings on the screws. The carbons may be small or large, the standard size for commercial arcs being ½ inch diameter. A spiral spring G, formed of phosphor bronze or steel wire, pulls the bar I downward. The glass lamp chimney is retained in place by a wood or fiber ring. This arc lamp is well adapted for use in small motion picture machines, post card projectors, model search-lights, wireless telephones, speaking arcs, etc.

Fig. 2, (left) shows a balanced, straight-line-feed arc lamp which the amateur electrician will find easy to construct. Iron pipe can be used with standard flanges, etc., to make it with. The toothed rack is riveted to a piece of iron or steel rod A, the rack sliding in a slot in the front face of guide bar B. A pinion is mounted in this slot to mesh with the rack, the pinion being rigidly secured to the arc adjusting handle and shaft. The balance weight should just about balance the moving carbon holder. Fig. 2, (right) illustrates the rack and pinion action in standard handfed arc lamps.

Regarding the current to be used with it, this may be either A.C. or D.C. The arc will give a powerful light on 50 to 60 volts and 5 to 8 amperes. It works best with a ballast resistance in series; this may consist of a few short coils of iron or German silver wire about No. 20 gage. The resistance should be adjustable and for 110 volt circuits some resistance is absolutely necessary. For 110 volt D.C. service the value of resistance approximates 11 to 12 ohms. It may be in the form of a water rheostat.

Contributed by JAMES PRATT.

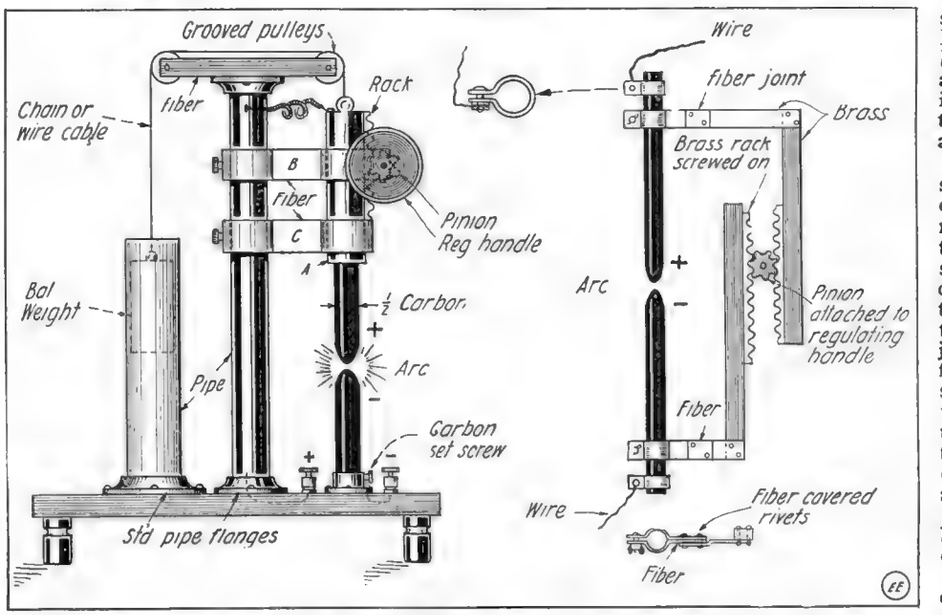


Fig. 2.—Hand-Feed Types of Arc Lamp Which Lend Themselves Readily to the Constructional Skill of the Amateur Electrician.

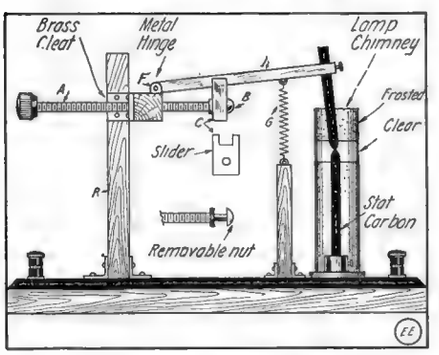


Fig. 1.—A Swinging Carbon Type of Arc Lamp for Amateurs.

TO KEEP HUMAN PESTS AWAY FROM YOUR AUTO.

How many of you fellows who own an automobile are, to put it mildly, peeved, to have some person leave their hand-marks on its glossy finish, or if it happens to be covered with a light film of dust, leave their delicately inscribed monogram traced therein. Some of this of course is thru carelessness and some thru the irresistible impulse of some people to see their name or trade-mark in every possible place. The result however is the same, leaving the car in a messy looking condition, and oftentimes actually injuring the finish.

My car, however, has of late been strangely immune from this slight source of annoyance apparently due to a "short" in the electrical connections. Whenever I am in the car and some "nut" starts exhibiting his skill in engraving on the metal body of the bus this short develops, and believe me, he suddenly loses all interest in his art, and rather shows a tendency to do a little vaudeville turn, executing something similar to the "Highland Fling."

The secret, however, lies in the fact that I have a small spark-coil connected to my storage battery and in turn connected to the metal body of the car, with a push button located in a place not readily seen, but at the same time easily got at, without attracting attention. I will not attempt to describe connections of this stunt, as anyone can easily hook it up. But take it from me it gives Results, with a capital "R".

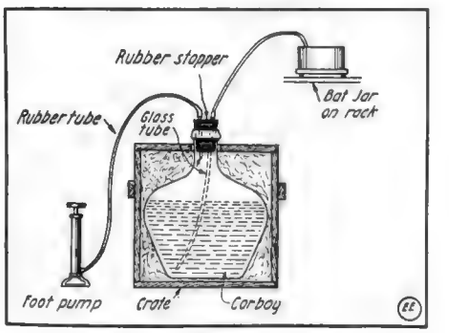
Contributed by H. H. L.

HOW TO PUMP BATTERY ELECTROLYTE FROM CARBOYS.

"Electrolyte for storage batteries is usually shipt in carboys which are heavy and unwieldy. The ordinary method of pouring the electrolyte or acid directly out of the carboy into pitchers or jars by means of which the individual battery cells are filled is a difficult task and results in considerable trouble, loss and contamination of solution, wasting of time, and frequently destruction of clothing. Where there are quite a number of stationary battery cells to be filled, as in the case of a new installation or where the electrolyte is being completely renewed," says George A. Broder, in *E. R. & W. E.*, "I find that a carboy pump similar to the one illustrated is a desirable adjunct.

"This device consists of a foot pump or bellows connected by a rubber tube to a rubber stopper in the neck of the carboy; from this stopper another tube leads to the jars or cells to be filled. The rubber stopper must fit very tightly, has two holes passing thru it and into one of these is placed a short piece of glass or hard-rubber tube to the top of which the tube from the pump is connected. Thru the other hole in the stopper passes a long piece of glass or hard-rubber tubing which is preferably curved slightly so as to reach the lowermost part of the carboy; this glass tube projects above the rubber stopper just enough to permit fastening the discharge tube or hose to it.

"The principle of the device is very simple. Air is forced in from the pump or bellows and creates a pressure on the surface of the electrolyte or acid in the carboy. This forces the electrolyte up thru the glass tube and discharge hose which can be carried to any jar or cell to be filled. The tubing should be of one-fourth or three-eighths inch internal diameter. By this device, especially if a bellows is used, a steady pressure can be maintained upon the electrolyte so as to secure a constant flow regardless of the amount of liquid left in the carboy; in fact the carboy can be emptied to almost the last drop. By placing a small pinchcock near the end of the filling or discharge hose, or by bending this hose sharply, it is possible to stop the flow of electrolyte without spilling a drop when changing from one cell to another."



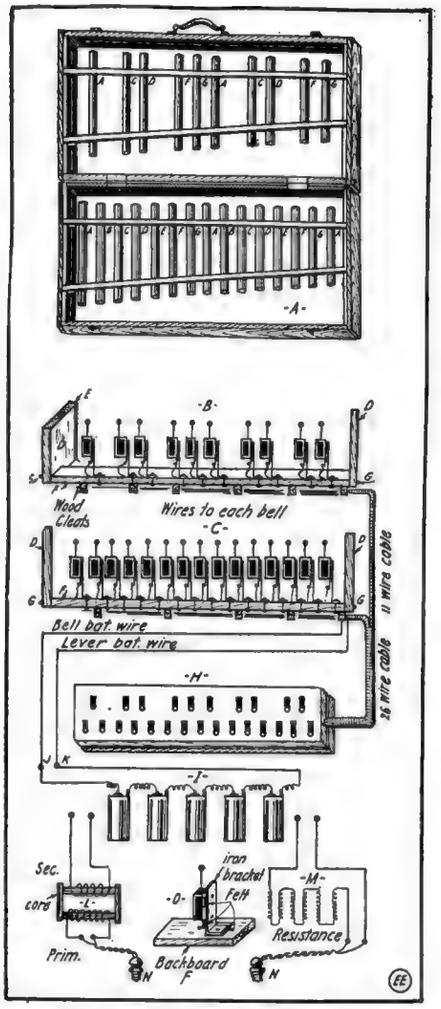
Method Whereby Battery Electrolyte Can Be Pumped by Comprest Air from Carboys Into Cells.

AN ELECTRIC PLAYER FOR TUBAPHONES.

By J. W. F. BOWLES

DOOR-BELL music would hardly appeal to city people any more than grass-hopper music to a farmer, but an apparatus, consisting of Drummers' Bells and ordinary electric house bells with the gongs removed, will produce music which is virtually door-bell music and which is finding favor with musicians patient and handy enough to construct the simple attachments.

As seen in the diagram, the working parts of ordinary vibrating bells are fastened to a frame, which sets over the rows of *tubes*. The bells as well as the frame itself are adjustable, making it possible to adjust the hammer of each bell to strike its corresponding tube squarely.



Even the Musician Finds Electricity Useful. Here We Have the Details for Making an Electric Player for Tubaphones.

Several keys may be struck at once. Any pianist or a drummer who plays bells can operate the key-board for which, however, a lingering touch is preferable to that of the pianists' staccato.

The instrument may be introduced into an orchestra as a novelty but in dance halls it may be used permanently with great success.

Description of Apparatus (See Illustration)

(A) Tubaphones in case.

(B) Frame with sharps and flats.

(C) Frame with naturals. To play the tubes the frames (B) and (C) are set over the tubes in case (A) so the hammer of bells strike the center of tubes.

(D) Supports for holding backboards.

(E) Felt under resting part of supports.

HINTS ON WEIGHING CHEMICALS.

Many of the chemicals used for making up battery and other solutions used by electrical experimenters can be weighed quite well upon a small piece of tissue paper, this being used to keep the scale pans clean. Another piece of paper of the same size should be placed in the other pan to avoid errors in weighing. Some such dodge as this is particularly useful when a cheap balance is used, having the pans suspended by means of thin cords past thru holes in their edges. These cords retain small particles of the substances weighed and so give rise to impurities in solutions subsequently prepared.

A better plan than the above is to use a couple of watch or clock glasses, two being required so that one does not have to wait while the glass is washed after a previous weighing. With the tung of a file scratch a circle on the back of one glass, and a cross on the other. Then make two counterpoises from thin sheet metal, making one round and the other like a Maltese cross, to avoid all possibility of mistaking which is which.

Contributed by H. J. GRAY.

Same on balance of (E) supports.

(F) Backboard containing the bells.

(G) Adjusting screws for adjusting bell to strike tubes to various pitches.

(H) Leverboard or keyboard on which are mounted the keys to make circuit to bells. The keys are arranged in an order corresponding to the tubes in order.

(I) Five one and a half volt dry cells. Wet batteries can be employed in the same manner and circuit. If open circuit batteries are employed and a greater quantity of current is required (which is necessary when the bells are in continual service) the batteries should be placed in multiple-series, which means a repetition of the present set connected, positive to positive and negative to negative. As well as the former, alterating or direct current from power lines can be attached to the outfit as described under (L) and (M).

(J) Positive binding post and bell battery wire.

(K) Negative binding post and key battery wire. (J) and (K) can be reversed, as there is no set positive and negative connections to the operating apparatus.

(L) Step-down transformer apparatus reducing the voltage from 110 volts to 8 volts on alternating current circuits. An attachment plug is connected with a length of No. 16 flexible wire, with reinforced insulation, and is then attached to the primary side of the transformer. The secondary side of transformer has wires provided to connect to (J) and (K) binding posts—eliminating battery wires.

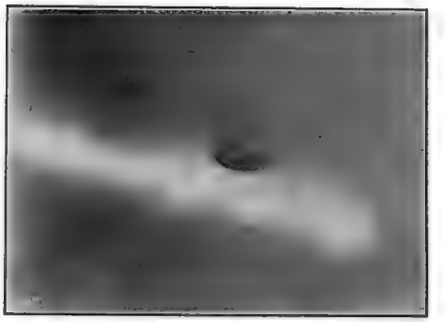
(M) A direct current power line circuit with resistance to reduce the voltage from 110 volts to 8 volts. Connections can be employed in the same manner as described under (J) and (K).

(N) Attachment plugs that will fit any Edison socket or receptacle.

(O) Shows how individual bell is mounted to backboard (F). The band iron brackets are fastened to the backboard by means of stove-bolts. The bell is also secured to the bracket in the same manner with a piece of felt between the two, to eliminate any foreign sound while the bells are in action. The bells in this equipment have two ohms resistance and must all be of the same make and adjustment. The wire is No. 18 for sections and No. 16 for battery or main lines which are lettered (J) and (K). The wires in the present equipment are individual, have rubber insulation and are cabled. A standard cable can be employed if the distance between parts is great.

AN INTERESTING RADIOGRAPHIC EXPERIMENT.

The following experiment, which I worked up several years ago, has always proved of interest to men somewhat advanced in scientific experimentation.



Radio-Activity Is an Absorbing Study; Here We Have a Photo Made by Exposing a Covered Plate to the Rays of Uranyl-Chlorid.

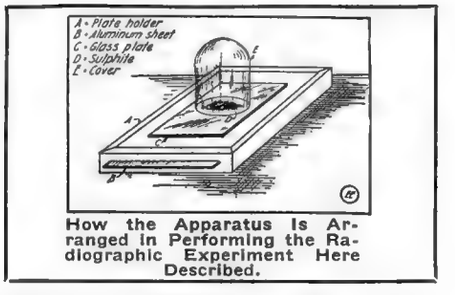
An experiment of interest to those who find pleasure in Radiography is that performed by Niewenglowski several years ago. The material furnishing the radiations is, in this case, *calcium sulfid,* such as is used in the manufacture of phosphorescent paint. A photographic plate is placed in a plate-holder A, and instead of a cover-slide, a thin sheet of aluminum, B, is inserted. Upon the aluminum are placed squares of thin glass, and on these pieces of calcium sulfid, D, previously exposed for some time to sunlight. These are protected by a cover glass, E.

The apparatus is left in the dark for twenty-four hours or so and the plate then developed. The particles radiating from the sulfid will have penetrated the aluminum and affected the sensitized photograph plate.

The phenomenon is similar to that observed about the same time as Niewenglowski by Becquerel, in respect to the salts of *Uranium.* It was later found, however, that the uranium salts exhibit this property of affecting a plate without previous exposure to light.

From the similarity to the action of the recognized radioactive elements, and from the accepted theory of radioactivity, an explanation for this phenomenon can be derived. The calcium atom in the salt *explodes,* or decomposes, as does Radium and the other radioelements, giving rise to a yet unknown substance (perhaps a *calcium emanation*), and the characteristic penetrating rays; from their nature, the B-rays. It is these B-rays which penetrate the aluminum and affect the plate. That the calcium salt must be exposed to light in order to secure this radioactivity is probably due to the radio-weakness of calcium.

(If the experimenter is able to secure any of the uranium salts, either from a reputable chemical house or from the ore, results will be much more easily attained and will be more satisfactory. The accompanying photo print was made from uranyl-chlorid.)



How the Apparatus Is Arranged in Performing the Radiographic Experiment Here Described.

Contributed by J. S. MARCUS.
(University of Colorado.)

HOW TO MAKE IT

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

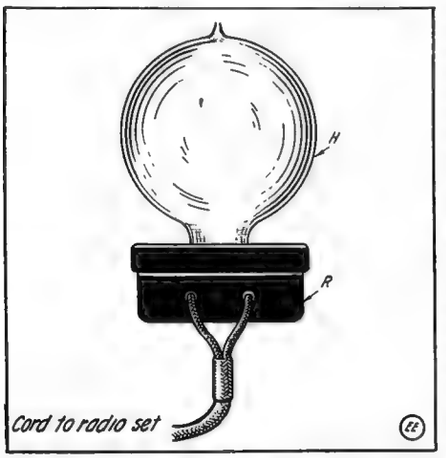
A NOVEL ACOUSTIC AMPLIFIER.

An amplifier which nearly equals an Audion in its sensitiveness and which requires no battery current to operate it is described herewith.

It is however better suited for use in regenerative vacuum detector receiving sets, that use a capacity to vary the number of beats.

Referring to the illustration, R is the telephone receiver (of 1,000 or 1,500 ohms resistance), while H is a *Helmholtz* resonator. The resonator is mounted so that the large opening fits over the hole in the ear cap of the receiver.

The number of beats is then regulated (by turning the variable condenser) until a clear response is heard. As a resonator of this type responds only to a *certain note*, the beats must be regulated until the reso-



The Simplest Amplifier for Radio Is That Shown, Which Involves the Use of a Helmholtz Resonator.

nator is in resonance with the receiver.

The system may also be used (with somewhat less efficiency) on an ordinary wireless set, i.e., one using a crystal rectifier, by first carefully ascertaining the pitch of the incoming signal and then choosing a resonator of the proper pitch.

Contributed by F. G. THACKABERRY.

LOCATING ARMATURE GROUNDS WITH A TELEPHONE RECEIVER.

A simple method for locating a grounded coil in an armature, will appeal to all electricians having to care for motors or generators. This test can be made without removing the armature.

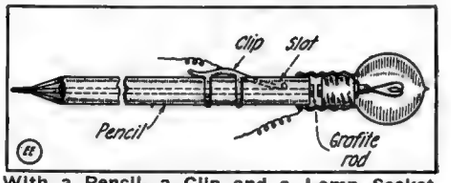
Remove all the brushes from the commutator with the exception of two located diametrically opposite. These brushes are connected to a few cells of dry battery and a buzzer, as shown in the illustration.

A telephone receiver has one terminal connected to the frame of the machine, while the other terminal is connected to a

SECOND PRIZE, $2.00

COMBINED PENCIL RHEOSTAT AND LAMP SOCKET.

Here is an improvement on my vest-pocket rheostat described in the October, 1916, issue of THE ELECTRICAL EXPERIMENTER, and as now constructed, it will be found very handy for testing the strength of small lamps.



With a Pencil, a Clip and a Lamp Socket Shell One May Construct a Vest-pocket Rheostat and Lamp Socket.

In addition to slotting the pencil and making the other details, secure a socket from a porcelain base, such as are used for miniature lamps, and force this over the end of the pencil. If necessary, an adhesive may be employed. Make the wire connections as shown, so that the current will travel via the inserted lamp after passing thru the grafite resistance, as regulated by the fountain pen clip.

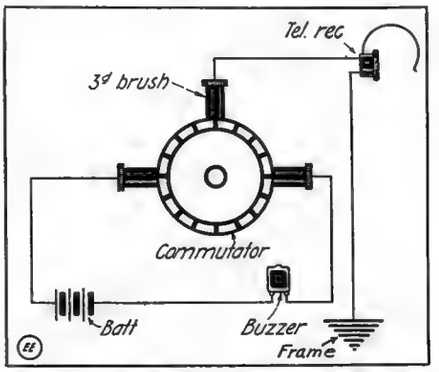
Contributed by JOHN T. DWYER

third brush, which bears on the commutator midway between the other two.

On starting the buzzer a sound will be heard in the 'phone. The armature should then be turned slowly, keeping the brushes in the same relation to each other, until no sound is heard in the telephone; this will indicate that the bar connected to the grounded coil is under the middle brush.

Due to the winding in wave-wound armatures it will be found that there are as many "silent" or nearly silent bars as there are poles in the machine. The proper one can be found by selecting the one which gives the least sound in the receiver. Should more than one be entirely "silent" increase the number of batteries in series with the buzzer until it is found that one bar gives less noise than the others in the series.

Contributed by THOS. W. BENSON.



Method of Testing for "Grounds" on Motor and Dynamo Armatures with a Buzzer, Battery and Telephone Receiver.

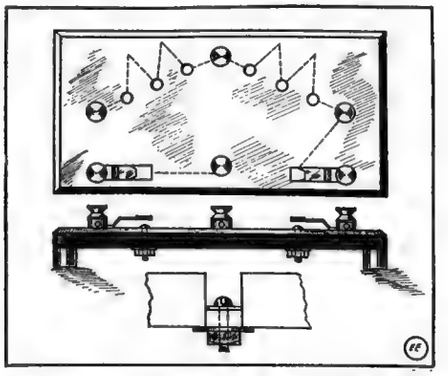
THIRD PRIZE, $1.00

A SIMPLE WHEATSTONE BRIDGE.

Select a piece of board of dimensions 8" x 15" x 1" thick. This should be well-seasoned wood, preferably some non-resinous kind. Bore holes for the binding-posts and the mercury cups, as shown in the drawing.

The contact keys are made of strips of hard sheet brass, bent as shown.

For the ratio coils No. 22 B. & S. double-cotton covered, German silver wire will be found the most convenient. It is very desirable to adjust these coils to exactly one and ten ohms each respectively, but this is not essential. Good results can be obtained by simply measuring off lengths of one and ten feet very accurately. The resistance of these wires will not vary greatly from the values marked, and their ratio will be very close to 10 : 1, which is the essential thing.



The Amateur Electrician Will Find This Small Wheatstone Bridge Useful As Well As Instructive.

All permanent connections shown in the sketch should be very carefully soldered on the under side of the bridge. A coat or two of orange shellac will make a neat appearance.

This apparatus, used in connection with an ordinary resistance box (.1 to 110 ohms), will give a possible range for measurements from .01 to 1100 ohms.

This bridge will commend itself on account of its teaching value, since it follows the theoretical Wheatstone bridge design very closely. Another good feature is its low cost. The necessary materials need not cost over seventy-five cents, and the labor involved in its construction is very small.

Contributed by PETER J. M. CLUTE.

Due to the advent of the war, we are particularly desirous of obtaining manuscripts describing original and practical "Electrical Experiments." We shall continue to publish Radio articles, but what we need is snappy "Electrical" articles. Be on guard for the enemy—Repetition!

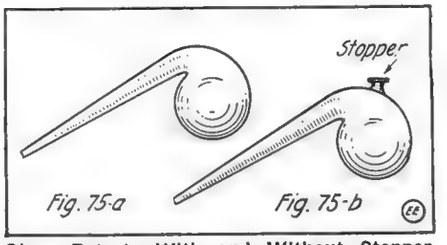
Experimental Chemistry

By ALBERT W. WILSDON

Fifteenth Lesson

NITRIC ACID. (HISTORY). (HNO_3)

NITRIC ACID was probably known to the ancient Egyptians and alchemists as Aqua Fortis (Strong Water). Geber is credited with having prepared it in the Ninth Century by strongly heating a mixture of



Glass Retorts With and Without Stopper. They Are Used Extensively in Chemical Researches.

Saltpeter (Potassium Nitrat), Alum, and Copper Sulfate, the Nitric Acid distilling over, owing to the decomposition of the Saltpeter by the Sulfuric Acid of the other salts. Nitric Acid was commonly prepared and used as a valuable reagent by the alchemists, especially as a means of separating Gold from Silver.

(*Synonyms — Aqua Fortis, Strong Water, Azotic Acid, Hydrogen Nitrat, Hydric Nitrat, Spirit of Niter.*)

Glauber about 1650 prepared it by a similar method to the one which is now used, namely, by the action of Oil of Vitriol (Sulfuric Acid) on Niter (Potassium Nitrat).

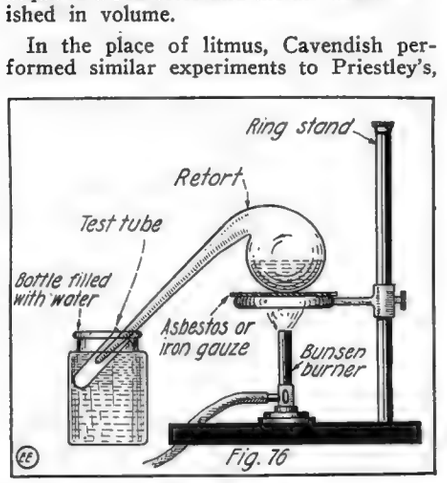
Lavoisier first determined the composition of this acid about 1776. He proved that one constituent was Oxygen, but was unable to prove the nature of the others.

Cavendish proved the exact composition and mode of formation of this acid of its salts by the direct combination of Oxygen gases in the presence of water or alkaline solutions.

Priestley, from his experiments, observed that when a series of electric sparks was made to pass thru air included between short columns of a solution of litmus, the solution acquired a red color and the air was diminished in volume.

In the place of litmus, Cavendish performed similar experiments to Priestley's, using what was known as *Soap-lees* (Caustic Potash) and Lime-water. He concluded that the Soap-lees (Caustic Potash) and the Lime-water became saturated with some acid during the operation. He proved that this was Nitric Acid, by passing the electric discharge thru a mixture of pure Dephlogisticated Air (Oxygen) and pure Phlogisticated Air (Nitrogen) over Soap-lees (Caustic Potash), when Niter (Potassium Nitrat) was formed.

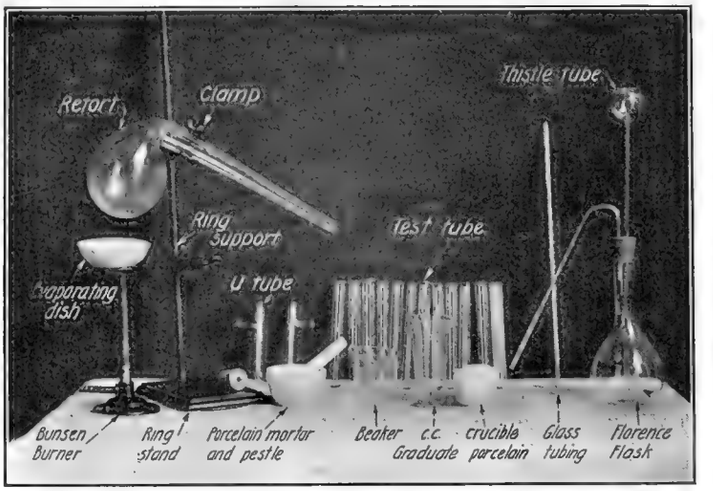
In 1816, Gay-Lussac found the ratio of Hydrogen, Oxygen, Nitrogen, corresponded with H_2O, N_2O_5.



Method of Setting Up Retort, Bunsen Burner, Condenser, Etc., In Experiment No. 82.

OCCURRENCE:

Like Hydrochloric Acid, Nitric Acid does not occur in the free state in Nature, its affinities being too strong. After thunder-storms, or electrical discharges in the air, traces are found. It occurs in large quantities combined in the form of Alkaline Nitrats, the two important ones being Sodium Nitrat [$NaNO_3$], found in large quantities in Chile, and also being known as Chile Saltpeter; and Potassium Nitrat [KNO_3] which is found in India, also known as Niter, Saltpeter, and Bengal Saltpeter.



Typical Outfit for An Experimental Chemist's Laboratory. Hundreds of Important Experiments Can Be Performed with This Equipment.

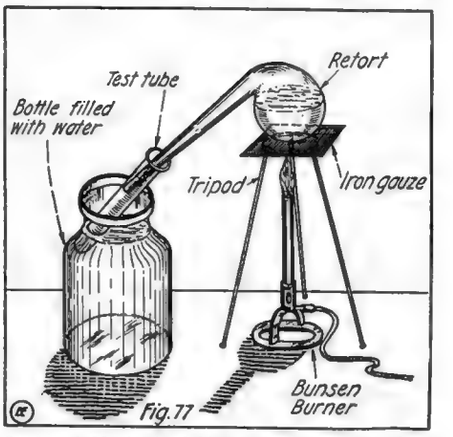
The formation of the nitrats are supposed to have their origin in the putrefaction of nitrogeneous or organic matters, the latter are assumed to be converted into Ammonia [NH_3], and this to be oxidized in the presence of the hydrat of potassium [K], Sodium [Na], or Calcium [Ca], into the corresponding nitrat.

PREPARATION:

The acid is prepared both commercially and in the laboratory by the action of Sulfuric Acid on some Nitrat.

Either Potassium or Sodium Nitrat may be employed, but owing to the greater abundance and less expensive cost of Sodium Nitrat, this is generally used.

When Sodium or Potassium Nitrat is mixed with dilut Sulfuric Acid, no obtrusive sign of chemical action takes place, altho it can be proved that a reversible change has taken place, so that the Sodium is distributed between the Sulfuric and Nitric Acids. If a mixture of concentrated Sulfuric Acid and Sodium Nitrat be heated to about 130°, Nitric Acid



Optional Method of Mounting Retort on Iron Tripod for Performing Experiment No. 82.

[HNO_3], is volatilized. The reaction is represented

$$\underset{\text{Sodium Nitrat}}{NaNO_3} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Sodium Hydrogen Sulfate}}{NaHSO_4} + \underset{\text{Nitric Acid}}{HNO_3}$$

The two salts, Sodium Nitrat [$NaNO_3$] and Sodium Hydrogen Sulfate [$NaHSO_4$] are not volatile. The Nitric Acid boils at 86°, the Sulfuric Acid boils at 330°. It is thus obvious, when heated at 100°, the Nitric Acid is volatilized and the state of equilibrium of the solution disturbed, thus the Sodium Nitrat is all decomposed.

If the temperature be higher, Normal Sodium Sulfate [Na_2SO_4] is formed, requiring the use of less Sulfuric Acid.

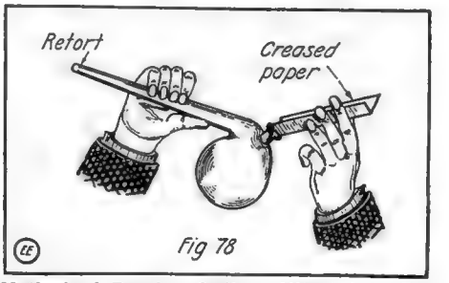
In comparison of the two equations:

$$\underset{\text{Sodium Nitrat}}{NaNO_3} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Sodium Hydrogen Sulfate}}{HNaSO_4} + \underset{\text{Nitric Acid}}{HNO_3}$$

and also

$$\underset{\text{Sodium Nitrat}}{2NaNO_3} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Sodium Sulfate}}{Na_2SO_4} + \underset{\text{Nitric Acid}}{2HNO_3}$$

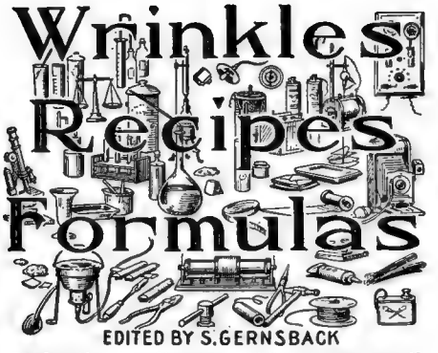
we can see that these reactions are similar to those obtained when we prepared Hydrochloric Acid [see July, 1917, issue of the ELECTRICAL EXPERIMENTER], insofar



Method of Pouring Sodium Nitrat Into Retort from a Creased Paper. Experiment No. 82.

that an excess of acid is employed, as in the first reaction, a moderate heat is re-

(*Continued on page 274*)



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

USEFUL CHEMICAL HINTS FOR AMATEURS.

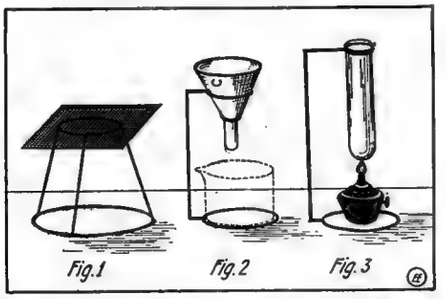
In many chemical experiments a ring-stand is needed, but as these are somewhat expensive a substitute will be welcome. The stand is made of two rings of heavy iron or copper wire, one larger than the other, with three supporting legs. The ends of these are bent around the rings at equal distances. The stand should be covered with a double thickness of screen-wire upon which the vessel to be heated is placed. The stand should be of the proper height in relation to the heater (lamp or Bunsen burner). This stand is illustrated in Fig. 1. A funnel stand is shown in Fig. 2 and a test-tube stand at Fig. 3.

An inexperienced visitor to your laboratory will be mystified and his admiration increased when you unconcernedly dip a piece of copper into a liquid in a bottle and bring it out coated with what seems to be silver. The liquid is prepared by dissolving a drop of mercury in a little nitric acid.

If some paper that has been soaked in starch solution and dried is dropt into a mixture of sulfuric acid and potassium permanganate, it will flash several times and throw a very light black residue for several inches. This experiment looks like a miniature volcano.

Invisible ink may be made by diluting one part sulfuric acid with twenty parts water. This ink is visible only when heated very hot.

Contributed by A. C. SIMPSON.



Several Useful Wrinkles for the Young Chemist Are Here Suggested. The Stands Shown Can All Be Made of a Piece of Wire, Properly Bent.

PERCENTAGE SOLUTIONS.

Many persons appear to find a difficulty in working with solutions containing *so much per cent* of an ingredient. There is no reason why confusion should ensue, for percentage solutions are as easy to prepare as those whose constitution is otherwise exprest, neither is there any greater difficulty in diluting to some weaker percentage strength. The following points are worth bearing in mind:

To convert percentage strength into ounces per pint, divide by 5. Thus, 20 per cent ÷ 5 = 4 oz. to the pint.

To convert ounces per pint to percentage strength, multiply by 5. Thus, 5 oz. to the pint × 5 = 25 per cent strength.

The rule for diluting is equally simple. To dilute a 25-per cent solution to 15 per cent, take 15 parts of the former and add sufficient water to make up to 25 parts (ounces, cubic centimeters, or otherwise). Or, to put it in general terms, for the rule applies to all strengths, to dilute a solution of A per cent strength to make one of B per cent strength, take B parts of the strong solution and add water to make A parts in all.

Contributed by H. J. GRAY.

THAT TEST FOR FREE AMMONIA.

In the May, 1917, issue of your magazine, you publisht an article written by W. R. Spurrier, on "Chemical Experiments."

In experiment number seven, Mr. Spurrier calls attention to Phenolphthalein being a test for free Ammonia. As this is decidedly wrong, kindly publish the following experiment and test, lest some young chemist be misled.

(1)—Experiment proving that any alkaline solution will turn a bright red when Phenolphthalein is added.

Make up a weak solution of Ammonia water (about five or six drops of Aqua Ammonia to four ounces of water), a few drops of Phenolphthalein (25% Alcoholic solution) will turn this solution to a bright red. Neutralize this solution by adding concentrated Hydrochloric acid (HCl), drop by drop, until it is again clear. ($NH_4OH + HCl = NH_4Cl + H_2O$.) If a small piece of Potassium metal (K), be dropt in this clear solution, it will burn and at the same time slowly redden the solution again. Try a fresh solution, using another alkali than Aqua Ammonia, (NH_4OH), eliminating the Potassium metal, (K), and note results.

Caution:—

Handle Potassium metal with forceps. Keep face from solution when adding the metal, as a small explosion frequently occurs. Do not allow any water to come in contact with K, while handling it.

(2)—Test for free Ammonia (NH_3) or Ammonium compounds (NH_4—).

Mix unknown with any hydroxid, preferably Sodium Hydroxid (NaOH), if a solid, add enough water to cover the same in a test tube. Heat gently, test the gas that is given off, by holding a piece of paper which was previously dipt in concentrated Hydrochloric acid (HCl), over mouth of test tube. If Ammonia is present, white fumes will appear. Moistened red litmus paper will turn blue when held over mouth of test tube.

The white fumes are solid particles of Ammonium Chlorid (NH_4Cl). The free Ammonia (NH_3), given off by the Ammonium compound combines with the Chlorin (Cl), of the Hydrochloric acid forming (NH_4Cl).

I am a reader of your excellent magazine and will continue to be as long as it is printed. With apologies to W. R. Spurrier.

Contributed by CHAS. A. HASEK.

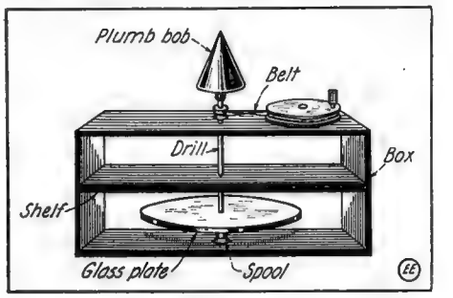
HOW TO CHANGE THE TONE OF ANY GONG.

Take the ordinary gong and cut a deep groove or a slot in it with a hack saw and it immediately changes the tone to a cow-bell.

Contributed by JULIUS FRANKS.

AN EFFICIENT PLATE GLASS DRILL.

In making a static machine, it is preferable to have the glass plates drilled in the exact center to allow passage of the spindle or axle, but the accomplishment of this task is a stumbling block to the amateur constructor and even difficult for those more skilled in workmanship. However, the simple drill apparatus shown herewith will do the trick very nicely and, while a little patience is necessary, the excellent results will more than compensate for the time and energy expended.



Simple Home-made Apparatus for Drilling Holes in Plate Glass for Static Machines, Etc.

First procure a wooden box, size about 17" x 10" x 7" and force out the top and bottom of the same, after which construct a shelf as shown. Then drill thru both the top piece and this shelf a hole, size of which should be of such a diameter as to allow the tube of an ordinary curtain rod to revolve freely and not too loosely. Take the brass rod that was inside of this tube, cut off a piece about 6" in length and insert one extremity into the bore of a carpenter's plumb bob. This latter should be as large as possible and weigh at least one pound. Now, saw off both ends of an ordinary thread spool and then glue together in such a manner as to form a pulley, after which fasten rigidly to the top of the drill, directly underneath the plumb bob. To give greater speed to the drill, make a larger pulley as shown and connect together by means of a leather belt. I may say, however, that this method will not be found very satisfactory, as the stretching tendency of the leather will in a short time cause the belt to slip and thus prevent motion entirely. A better and simpler way is to merely hold the belt at both ends, fit into the groove of the small pulley, and then pull forward first with one hand and then the other, which action will give a continual alternating circular motion to the drill.

When everything has been completed, insert the rod, to which the plumb bob is attached, into the drill or tube, being careful beforehand to pour in a small quantity of emery. In as much as this substance is difficult to get in a loose form, I would suggest that the reader do as I did and buy a few sheets of regular emery paper. These should first be torn up in small pieces, then put in a metal pot or pan and finally set fire to. The paper will burn away, leaving the emery grains, which can be easily separated from the paper ash by sifting thru a fine strainer. For the purpose of raising the glass plate upward so that the full weight of the plumb bob is brought to bear, glue a large thread or cotton spool to its center. As the hole of the latter can be seen thru the glass, this will also act as a guide in drilling.

From time to time, in operating this drill, add a little machine oil to the emery in order to provide a lubricant and thus prevent the glass from cracking. Also roughen the end of the drill with a file, so as to give it a sharper and therefore better cutting edge.

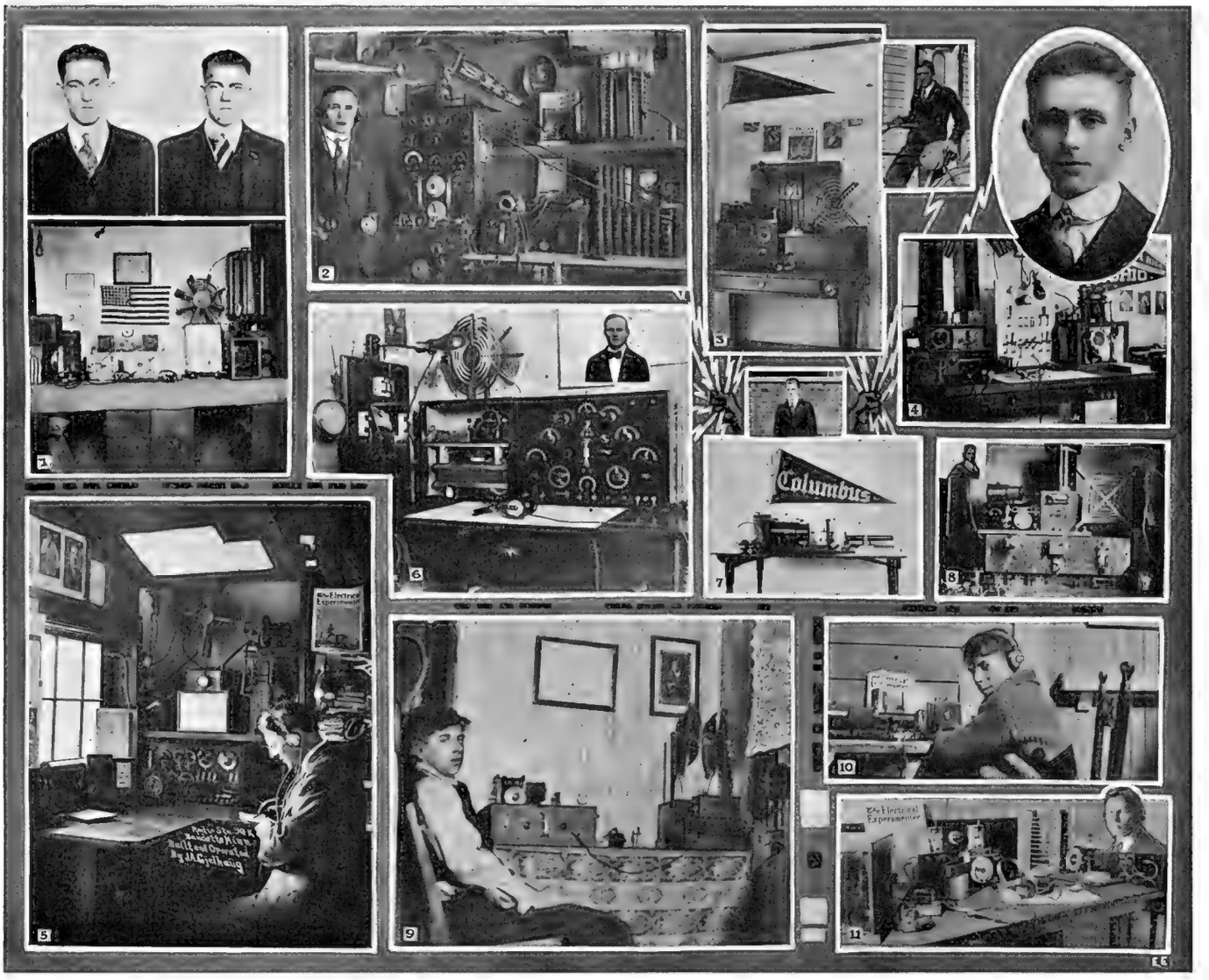
Contributed by JOHN T. DWYER.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

$15.00 Cash in Prizes. Get Busy, Boys!!!

Here is your chance to win a cash prize for a few minutes' brain work. The big question now confronting every radio amateur is—"What can I do with my wireless apparatus?" To help the more than 400,000 loyal radio students and enthusiasts to apply their knowledge and, most important of all, to utilize their instruments for some practical electrical or communication purpose **other than wireless,** we shall pay two prizes—one of $10.00 and one of $5.00 respectively, for the best suggestion as to "what to do with your radio set during the war." Be brief; 100 to 200 words should tell your story. Remember—it's the "idea" that counts. Get busy at once, boys, as we want all suggestions in by July 25th, at the latest, so that the results can be announced in the September number of THE ELECTRICAL EXPERIMENTER. And don't forget we must have thoroly "practical" ideas. Address the Editor, Radio Problem Contest.



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR RADIO STATIONS.

Radio Stations of, 5—J. A. Gjelhaug, C. E. Baudette, Minn. (Prize Winner); 1—Seefred Bros., Los Angeles, Cal.; 2—Greer W. Peck, Springfield, Tenn.; 3—George M. Stuff, So. Auburn, Nebr.; 4—Leo Hirsch, Columbus, Ohio; 6—Robert A. Gerhard, Lehighton, Pa.; 7—Everett Crump, Columbus, Ind.; 8—Donald S. Bennett, Wollaston, Mass.; 9—Maurice Pollack, Chicago, Ill.; 10—Charles Cross, Oakland, Cal.; 11—L. H. Cook, Mexico, N. Y.

TESLA'S VIEWS ON ELECTRICITY AND THE WAR.

(*Continued from page* 230)

"At the time of those tests I succeeded in producing the most powerful X-rays ever seen. I could stand at a distance of 100 feet from the X-ray apparatus and see the bones of the hand clearly with the aid of a fluoroscope screen; and I could have easily seen them at a distance several times this by utilizing suitable power. In fact, I could not then procure X-ray generators to handle even a small fraction of the power I had available. But I now have apparatus designed whereby this tremendous energy of hundreds of kilowatts can be successfully transformed into X-rays."

"Could these ultra-powerful and unusually penetrating X-rays be used to locate or destroy a submarine with?" I interjected.

"Now we are coming to the method of locating such hidden metal masses as submarines by an *electric ray,*" replied the electrical wizard. "That is the thing which seems to hold great promises. If we can shoot out a concentrated ray comprising a stream of minute electric charges vibrating electrically at tremendous frequency, say millions of cycles per second, and then intercept this ray, after it has been reflected by a submarine hull for example, and cause this intercepted ray to illuminate a fluorescent screen (similar to the X-ray method) on the same or another ship, then our problem of locating the hidden submarine will have been solved.

"This electric ray would necessarily have to have an oscillation wave length extremely short and here is where the great problem presents itself; *i.e.,* to be able to develop a sufficiently short wave length and a large amount of power, say several hundred thousand or even several thousand horse-power. I have produced oscillators having a wave length of but a *few millimeters.*

"Suppose, for example, that a vessel is fitted with such an electric ray projector. The average ship has available from say 10,000 to 15,000 H.P. The exploring ray could be flashed out intermittently and thus it would be possible to hurl forth a very formidable beam of pulsating electric energy, involving a discharge of hundreds of thousands of horse-power. The electric energy would be taken from the ship's plant for a fraction of a minute only, being absorbed at a tremendous rate by suitable condensers and other apparatus, from which it could be liberated at any rate desired.

"Imagine that the ray has been shot out and that in sweeping thru the water it encounters the hull of a submarine. What happens? Just this:—The ray would be reflected, and by an appropriate device we would intercept and translate this reflected ray, as for instance by allowing the ray to impinge on a phosphorescent screen, acting in a similar way to the X-ray screen. The ray would be *invisible* to the unaided eye. The reflected ray could be firstly, intercepted by the one or more ships in the fleet; or secondly, it would be possible for the ship originating the ray to intercept the refracted portion by sending out the ray intermittently and also by taking advantage of what is known as the *after-glow effect,* which means that the ray would affect the registering screen an appreciable time after its origination. This would be necessary to allow the ship to move forward sufficiently to get within range of the reflected ray from the submarine, as the reflection would not be in the same direction as the originating ray.

"To make this clearer, consider that a concentrated ray from a searchlight is thrown on a balloon at night. When the spot of light strikes the balloon, the latter at once becomes visible from many different angles. The same effect would be created with the electric ray if properly applied. When the ray struck the rough hull of a submarine it would be reflected, but not in a centrated beam—it would spread out; which is just what we want. Suppose several vessels are steaming along in company; it thus becomes evident that several of them will intercept the reflected ray and accordingly be warned of the presence of the submarine or submarines. The vessels would at once lower their nets, if so equipt, order their gun crews to quarters and double the look-out watch. The important thing to know is that submarines are present. Forewarned is forearmed!

"The Teutons are clever, you know; very, very clever, but we shall beat them," said Dr. Tesla confidently. [*It may be of interest to our readers to know that several important electrical war schemes will shortly be laid before the War and Navy Departments by Dr. Tesla, the details of which we naturally cannot now publish.*]

BLINDING THE SUBMARINE.

(*Continued from page* 235)

foredoomed to failure. To counteract strong sunlight on a silvery dazzling ocean requires a very strong light as every sailor knows. Also if the periscope is two or more miles off, a small searchlight would hardly be noticed by the U-boat commander, even if trained full on him. For that reason only a very powerful light will do. Perhaps large parabolic mirrors to reflect the sunlight could be used with fair cloudless skies, for there is no stronger and more blinding light than sunlight. On a clear day this would be perhaps preferable to using electric searchlights. At any rate the plan is not an expensive one and is certainly worth trying, foolish and idiotic as it may appear at first.

However, most of our everyday, mechanical reasoning is faulty. For thousands of centuries people fled in terror from lightning. No "sane" person up to Benjamin Franklin's time could have been induced to remain in a house where there was a good chance for lightning to strike. Most preposterous of all, no one would have been crazy enough to deliberately seek shelter in a house where he knew in advance that the lightning would strike, nine chances out of ten. The idea, of standing right under the lightning for protection!! Nevertheless people got over their foolish notions when Benjamin Franklin began sticking lightning rods on their houses. Today the lightning-rod protected skyscraper is hit frequently by thunderbolts, and people are so used to it that they much rather stay in a skyscraper than venture into the open during an electric storm. It is safer right under the lightning.

It is just so with the searchlight plan outlined above. Its very *apparent* danger is its safety. Think it over.

WOMEN RADIO OPERATORS TO AID UNCLE SAM.

(*Continued from page* 238)

charge of the Western Union's branch in the Leader-News building is supervising instructor in the telegraph room, and a real efficient pedagog she is, too.

Applicants for membership are required to give their vocation, their own and parents' nationality, their residence in the city, and education. The application blank states, however, that the applicant incurs no obligation. There is no expense whatever attached to the training. If women are placed thru their training in railroad service, it will doubtless require that they leave the city and take up work in small railroad stations. At least, that will be where the shortage of men employees will be most felt. Mr. Newman expects to have at least one hundred telegraph operators and a score of wireless operators qualified to take positions at the expiration of the present terms.

ELECTRIC SUBMARINE FORTS TO DESTROY SUBMARINES.

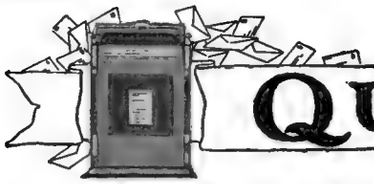
(*Continued from page* 231)

Ordinarily the device would be lowered into the sea from on board of a suitable vessel after the storage batteries are charged, the operator took his seat and the cylinder has been closed carefully watertight from outside. Suspended from a wire rope the steel unit would slowly descend to the bottom of the sea and the operator would himself feel nothing of the ever-increasing pressure of the water, but could comfortably observe his surroundings by turning on the light projector and rotating the device round its vertical axis. Through the telephone he would at all times remain in direct contact with the vessel, could at any moment stop the lowering of the device, the shock of which when striking the ground would be absorbed by a shock absorber arranged at the bottom of the device and ending in a ball, and arrived near a sunken vessel he could conduct and direct by means of the telephone any possible salvage operations.

For military purposes, however, this device can be adapted to contain at the same point in place of the camera a special arrangement of short torpedo tubes, each of which contains a special short-range torpedo which can be discharged at any moment by the operator simply by pressing a corresponding electric button, as soon as he detects a passing submarine and has his device adjusted in the right direction.

For such protective and defensive purposes the inventor believes that a number of such cylinders submerged across a given water-way, across the entrance to the harbor of New York, for instance, would doom to destruction any enemy submarine which would attempt to pass thru submerged. Each device could be connected to a floating buoy and anchored from the bottom of the bay from a special heavy casing which would contain an electrically operated drum upon which sufficient cable would be wound to allow the operator to rise to the surface and which would be controlled by the operator thru a special switch. Thus the operator could constantly oscillate slowly up and down under the water and rise every twelve hours at a certain time to the surface. A small vessel could at the same hour pass from one buoy to the other, open the cylinder as soon as its top would appear above water, let the operator out and another take his place. Where it is possible the electric current necessary could be supplied by an electric cable running from shore to all anchors and up into the devices in place of the storage batteries and also telephone connections could be established in the same way between all cylinders submerged and a coast station (fort) so that the operators could report at once everything of importance.

"Submarine chasers may be of great value," says Mr. Hartman, "but they have to limit their field mainly to the surface of the water as they cannot see a submarine which is running submerged at a certain depth; especially at night-time. It is more easy for a submarine commander to see the shadow of any dangerous small craft from below the water thru special lenses than to see the submarine at a certain depth."



QUESTION BOX

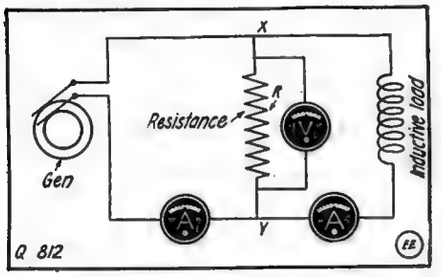
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions address to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

WIRING DIAGRAM.

(812.) David Langstrom, Chicago, Ill., desires:

Q. 1. How are the wiring connections made for the Fleming combined voltmeter and ammeter method of measuring power



Connections of Apparatus for Measuring the Power in A. C. Circuits by the Fleming Method.

in an alternating current circuit?

A. 1. The diagram herewith gives the proper connections. The true watts will be equal to:

$$W = \left(A_1^2 - A^2 - \left(\frac{V}{R}\right)^2\right) \times \frac{R}{2};$$

Where W = true watts
A_1 = Indication of generator current
A = Current consumed by load
V = Voltage across generator

If the voltmeter V, takes an appreciable amount of current, it may be tested as follows: Disconnect R and V at Y, and see that A and A_1 are alike; then connect R and V at Y again and disconnect the load. A_1 will equal current taken by R and V in parallel.

Q. 2. Why is the active pressure in phase with the current?

A. 2. The pressure used in overcoming resistance is from Ohm's law, $E = RI$. Hence, when the current is zero, E is zero and when the current is a maximum E is a maximum. Hence, that component of the imprest pressure necessary to overcome resistance must be in phase with the current.

FILAMENT TEMPERATURE.

(813.) Paul Hancock, Boston, Mass., asks:

Q. 1. What do you consider as the temperature of an incandescent lamp?

A. 1. A carbon filament runs at 1,700 to 2,100 degrees Centigrade. If the voltage is too high the lamp consumes too much current and the temperature of the filament becomes so high that it softens and droops until it may touch the glass bulb which cracks, allowing air to enter and burn out the filament. An abnormally high temperature also causes disintegration of the filament and causes its candle-power to drop off rapidly. Tantalum and tungsten filaments run hotter.

Q. 2. What kind of current is used in electric furnaces?

A. 2. Either direct or alternating current may be used in incandescent and some of the arc furnaces. Only the direct current can be used in furnaces dependent partly or wholly upon the chemical effect of the current, as in the production of aluminum.

REGENERATIVE AUDION.

(814.) Robert Murphy, Phoenix, N. Y., writes:

ODD PHOTOS WANTED AT $1.00 EACH!!!

Now is the time to make your Kodak pay for itself in a real practical way. We are after interesting photographs of out-of-the-ordinary electrical, radio and scientific subjects and are willing to pay $1.00 cash for every one we can use. Please bear in mind that for half-tone reproduction in a magazine, a photograph should be particularly sharp and clear. Of course, if a subject happens to interest us particularly well, we can have the photo retouched. For the general run of subjects, however, it does not pay to go to such expense. Therefore, please take pains to properly focus and expose your pictures. It often happens that a really mediocre subject well photographed wins approval over an excellent subject poorly photographed. And don't send us plate or film "negatives"; send unmounted or mounted "prints," preferably a light and a dark one.

As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 to 150 words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, 233 Fulton Street, New York City.

Q. 1. Do all regenerative receiving circuits change the individual tone of spark signals to a hiss when maximum amplification is employed? If not, please give diagram circuit for the de Forest round Audion, suitable for 200-600 meter spark signal reception, where the individual spark tone is retained.

A. 1. The tone received on the regenerative Audion circuit corresponds identically to that of the imprest frequency of the distant transmitter. However, in regards to the hiss in the receiver of such a system this is due to "overflow" effect ("spilling over") of the Audion at the high potential, which is essential in a regenerative circuit and which must be controlled in order to overcome this hiss. This effect is not one which is controlled by the distant transmitter but due to local conditions inherent in the system, which can be eliminated by proper adjustment.

The wiring diagram for a receiver capable of performing the duties in question is identical with the standard regenerative Audion circuit and which you will find given a complete description in the January, 1916, issue of this journal.

Q. 2. Which group of apparatus is best suited for undamped wave reception from foreign stations, the large, loose coupler using the Chamber's circuit, or the small coupler with its loading coils and condensers?

A. 2. The large, loose coupler with its accessories, such as condensers, etc., employing either the Chamber's or Armstrong circuits will be found to give best results.

Q. 3. In constructing an aerial for 200 meter transmission, what spacing of wires, what number of wires, and what length should they be, to give 160 meters natural wave length; the aerial to be of the "T" type with leads taken from the exact center?

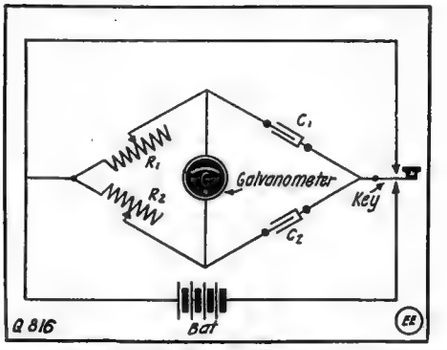
A. 3. The antenna for 200 meters should consist of four wires, 50 feet long, 60 feet high and the wires should be spaced two feet apart. The 160-meter antenna should consist of four wires 50 feet long, 40 feet high and each wire spaced the same as the 200 meter one.

CAPACITY MEASUREMENT.

(816.) J. Andricks, St. Louis, Mo., inquires:

Q. 1. What is the simplest and yet accurate method for measuring the capacity of a condenser?

A. 1. The bridge method is the simplest



Showing How the Bridge Method Is Applied for Measuring Condenser Capacities.

method for measuring the capacity of a condenser. This scheme employs a standard condenser and the unknown capacity

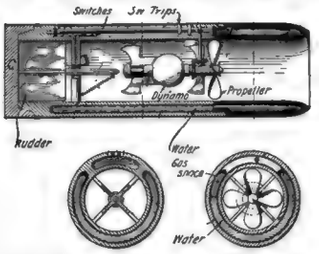
(*Continued on page* 275)

LATEST PATENTS

A Novel Electric Projectile

(No. 1,226,732; issued to Clarence W. White.)

One of the most radical projectile designs that we have come across, and which involves a novel application of electricity. The projectile is made in several sections and is

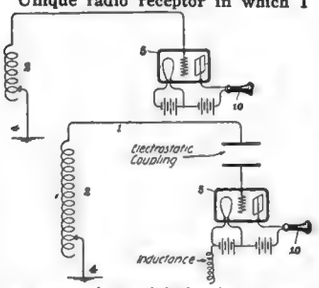


open thru the center except for detachable base cap c. By a clever arrangement of an air propeller connected to a dynamo, the inventor causes several things to happen, viz., —the cap c drops off as soon as the projectile is started on its way; a magnetically controlled rudder projects out at the back; electric current from dynamo is caused to act on a quantity of water in the annular chamber shown, causing oxygen and hydrogen gas to be evolved, and which is electrically exploded after a pre-determined time period. Moreover the projectile may be set to change its course, while in flight.

Radio Receptor

(No. 1,226,060; issued to Elmer E. Bucher.)

Unique radio receptor in which 1

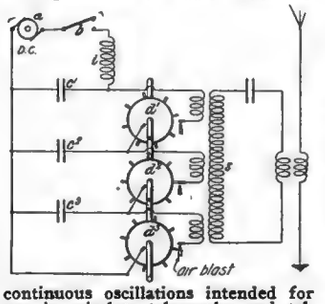


represents the aerial circuit, containing a tuning inductance 2, which is connected to the earth or a suitable capacity at 4. The aerial 1, preferably consists of a long horizontal conductor connected to the earth. The free end of the aerial being a point of maximum potential, is connected to a vacuum detector 5. The patent mentions the use of an inductance connected to the filament circuit as shown; this inductance being adjustable.

Generator of Radio Frequency Oscillations

(No. 1,226,099; issued to Guglielmo Marconi.)

A generator of radio frequency

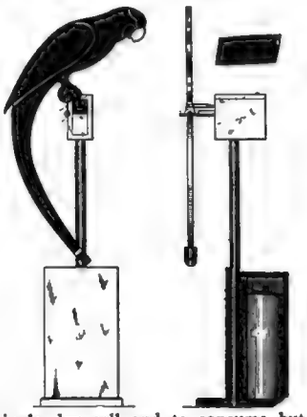


continuous oscillations intended for use in wireless telegraphy and telephony. Several series of insulated rotary spark gaps with comprest air blasts are used, and the oscillatory circuits are energized from a D. C. source a, controlled thru key b, and inductance i. The condenser C1 is caused to discharge into condenser C2, which discharges into condenser C3, which finally discharges thru a rotary gap d3, causing the oscillation transformer secondary S, to be powerfully excited, and which communicates its energy to the aerial circuit thru a second oscillation transformer.

Electrical Toy

(No. 1,226,835; issued to Allen B. Wilder.)

An efficient and simple self-acting electrical device for continuously operating swinging bodies such as toy birds and animals, advertising devices for window displays, etc. The device is claimed to operate on a

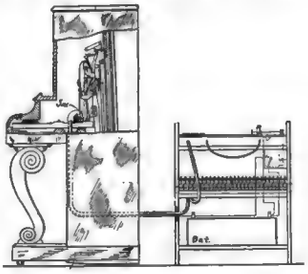


single dry cell and to consume but a very small current. The illustration shows a swinging parrot, properly counterbalanced. At the top of the upright stand is a small case containing a set of electro-magnets and a pivoted armature, provided with a contact spring which is actuated by the downward movement of the parrot. As the figure continues to swing forward, the contact is closed, and the electro-magnet at once attracts its armature which throws the figure upward, and thus the action continues to repeat itself.

Electrical Piano Attachment

(No. 1,229,122; issued to Donald Patrick Muse.)

A clever electrical piano attachment which permits of playing several instruments such as a violin

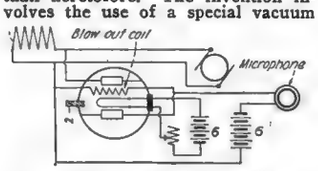


and orchestra bells in harmony with a piano when playing the latter. The desired result is accomplisht by arranging electrical contacts at the back of each piano key, and which control electric sounding devices which may play orchestra bells, a violin, etc. A flexible cable carrying one common wire and one additional wire for each sounding instrument, connects the piano with the separate cabinet containing the auxiliary musical instruments. The inventor has provided a means whereby it is possible for the musician to cut out any of the auxiliary musical instruments and their electrical playing attachments.

Signaling Device

(No. 1,223,589; issued to August J. Kloneck.)

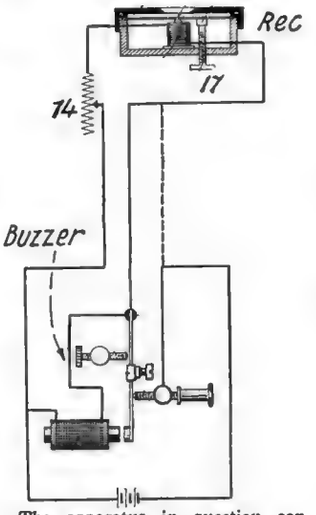
Means whereby high frequency oscillations may be produced and controlled with greater efficiency than heretofore. The invention involves the use of a special vacuum



bulb provided with a metal plug, which may be heated so as to pass gas from the atmosphere, and thus vary the degree of vacuum. The bulb also contains a heating filament, the usual grids and a small blow-out coil arranged within the chamber so as to control the thermionic currents by its magnetic field, the strength of which may be regulated by a microphone connected in the circuit. The operation of this oscillator is similar to the arc type, except that instead of the arc, the less luminous radiation of a larger area of electrodes is utilized, and the radiation of the current is occasioned by a glowing filament in the bulb.

Electrical Massage for the Ear

(No. 1,227,476; issued to Albert Maurice.)

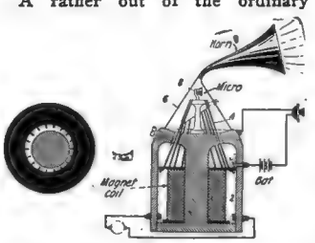


The apparatus in question consists of a telephone receiver connected with a circuit comprising a battery and a rapidly interrupted switch or contact, such as a buzzer.

Sound-Producing Device

(No. 1,228,639; issued to Erik C. Bayer.)

A rather out of the ordinary

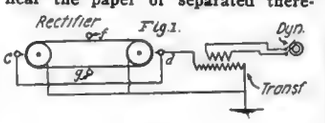


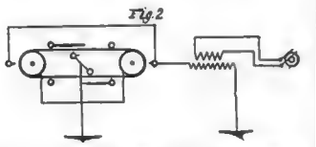
sound-producing device which may be used as a telephone relay or as a loud-speaking telephone. The apparatus produces acoustic vibrations from telephone or other currents thru the medium of a series of tightened non-magnetic wires connected in the circuit of the telephone transmitter. These wires are placed in a powerful magnetic field maintained by the large magnetizing coil 2. High amplification is claimed with this device, and by using a microphone 8, within the sound hood 6, the device acts as a telephone repeater with amplifying characteristics.

High Tension Electric Rectifier

(No. 1,228,405; issued to William H. Chapman.)

This invention is based on the fact that if a sheet of paper is laid on the surface of a grounded metallic body and a pointed conductor having an alternating charge of several thousand volts, be brought near the paper or separated there-





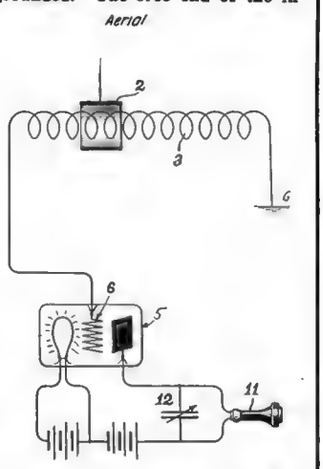
from by an air space for an instant, as it is in contact with the grounded conductor, the paper when moved from the surface of the conductor will show a very high negative charge of many times the voltage of the alternating charge.

The two metal rolls are grounded and as the paper travels around, it carries negative charges from "c" and "d" to "f" and "g." The apparatus in Fig. 2 is for producing positive electricity.

Radio Receiving Apparatus

(No. 1,228,647; issued to Elmer E. Bucher.)

The aerial connects to a metal band 2, which slides along an inductance coil 3, this coil being grounded. The free end of the in-



ductance coil is connected to the grid of vacuum bulb detector used in the manner shown, or a crystal detector may be used instead. It is seen that electrostatic coupling is thus employed and in tuning such a receiving set metal ring 2, is moved along coil 3, and also the degree of coupling may be varied by contracting or expanding ring 2.

COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH

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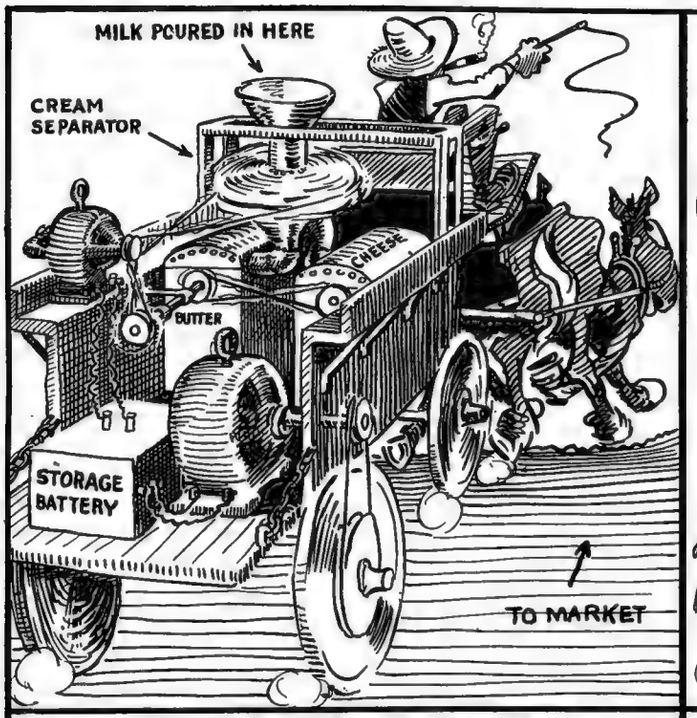

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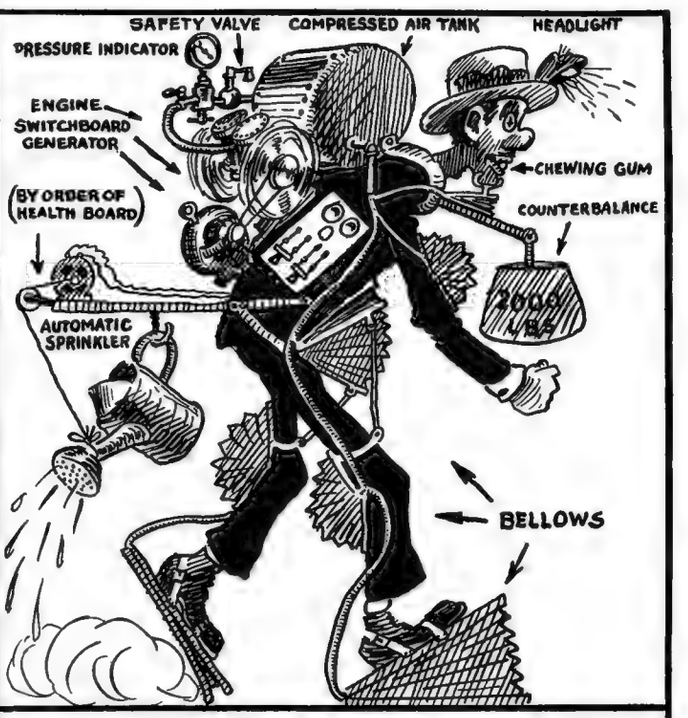

MAN-O-MOBILE

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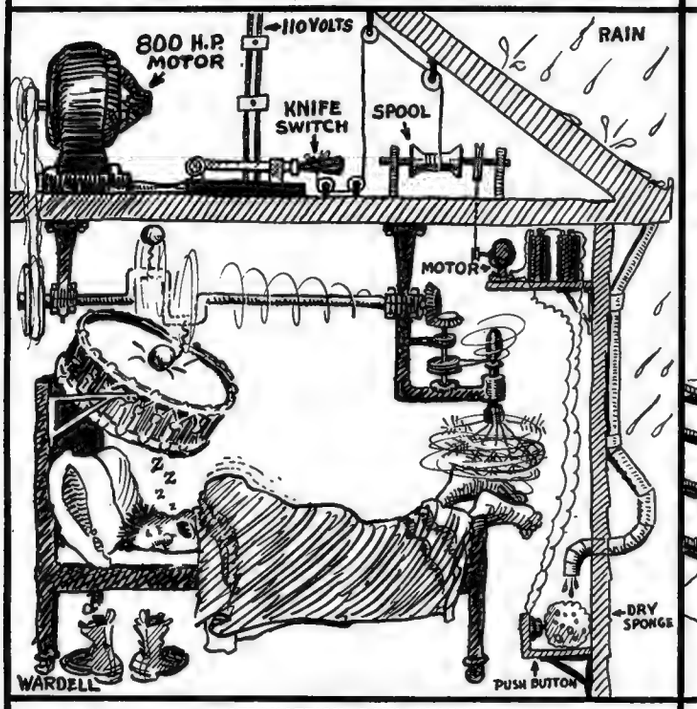
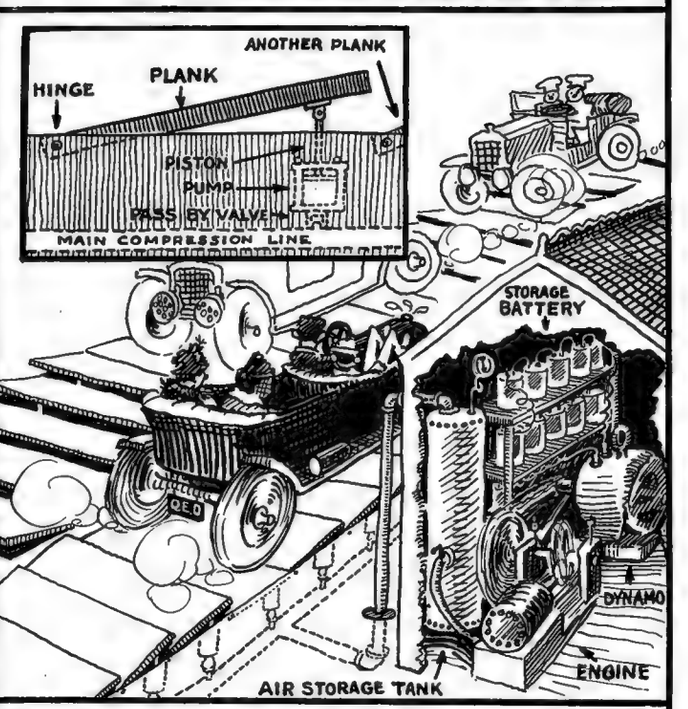
Inventor: Nameless (He Forgot to Send His Name).



OTTOMATTICK RAIN ALARM

This Patent Rain Alarm Provides for a Dry Sponge, Which When the Rain Expands it, Presses a Push Button; This Latter Operates the 800 H. P. Motor Which Works a Loud-Speaking Drum Over Mr. Sleeper's Head. If That Don't Wake Him, There's a Feather Duster to Tickle His Soles. Real Soulful.
Inventor: James Nelson, Paterson, N. J.



ROAD-O-MOTOR

First We Take a Lot of Planks and Hinge Them Along the Road on One End. Now Then, When the Flivvers Flivver By, the Planks Will Be Depresst. Compressing Air in the Compression Pipe-line. As Soon As the Flivver Passes, a Spring Under Plank Pushes It Up Again. The Compresst Air Drives the Dynamo.
Inventor: W. C. Heiber, Valdosta, Ga.

EXPERIMENTAL CHEMISTRY.

(*Continued from page 267*)

quired, which yields a readily soluble salt, Sodium Hydrogen Sulfate [$NaHSO_4$].

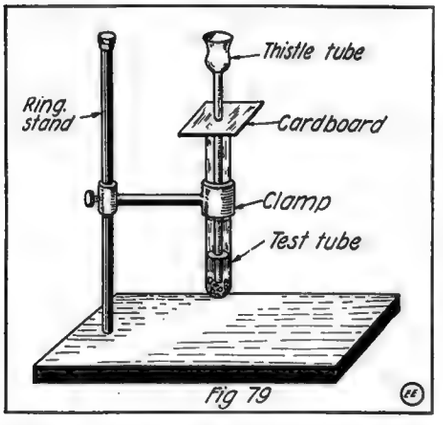
A higher temperature yields a Normal salt [Na_2SO_4]. For this reason moderate heat should be used when the acid is prepared in the laboratory.

Even at 86° some of the acid breaks up into Nitrogen Peroxid [NO_2], water [H_2O], and Oxygen [O].

$$\underset{\text{Nitric Acid}}{2HNO_3} = \underset{\text{Water}}{H_2O} + \underset{\text{Nitrogen Peroxid}}{2NO_2} + \underset{\text{Oxygen}}{O}$$

This dissociation is made apparent by the liberation of the red fumes, Nitrogen Peroxid [NO_2], and these dissolved on the acid impart a yellow or red color and increase its strength. It is then called Fuming Nitric Acid [sometimes erroneously called Nitrous Acid] and is extremely powerful and corrosive. After a time the fumes will mostly evaporate, though some combine with any water and oxygen present and form Nitric Acid.

Nitric Acid is prepared commercially by heating Sodium Nitrat and Sulfuric Acid in cast-iron retorts; the vapor being condensed in earthenware condensers, cooled by water, and collected in earthenware



Apparatus Used In Making the Copperas Test for a Nitrat. See Experiment No. 88.

jars. The last jar is connected with a tower filled with coke, down which a stream of water is allowed to flow. The object is to recover the Nitrogen Peroxid produced by the decomposition of the acid. The retort has an outlet pipe from which the Sodium Sulfate can be run when the action is completed. To reduce the amount of Nitrogen Peroxid formed during the decomposition of the Nitric Acid by heat, the stills are often worked under a reduced pressure to permit the acid to come off at as low a temperature as possible.

If the solution of Sodium Nitrat and Sulfuric Acid used to prepare the acid is weak, water will distill over first, but, if strong, Nitric Acid goes over first, an acid of quite constant composition is obtained containing about 68% Nitric Acid, which is the commercial product.

When the acid is prepared as above, it generally contains some Chlorin, and Iodin, derivatives or the Chlorids and Iodids associated with the Niter. In some cases some Sodium Sulfate, Sulfuric Acid and Iron are also carried over during the process of distillation. In order that the acid may be purified, it is distilled in glass retorts, and the first fraction which comes over is put on one side as crude acid containing Chlorin compounds. When no precipitate is observed upon the introduction of the distillat in a dilute solution of Silver Nitrat, the receiver is changed and the larger part of the Nitric Acid distilled off. The residue remaining in the retort contains the Sulfates, Iodin and Iron.

The acid can be redistilled from concentrated Sulfuric Acid to remove all the water; and the Nitrogen Peroxid can be eliminated by permitting a current of carbon dioxid to pass thru the warm acid until it is without color.

Professor Ostwald has patents on a process "For the Oxidation of Ammonia into Nitric Acid" and known as the "Ostwald Process."

Nitric acid may be prepared from the air, three important stages being involved. First, the Nitrogen and Oxygen of the air are combined to Nitric Oxid:

$$\underset{\text{Nitrogen}}{N} + \underset{\text{Oxygen}}{O} = \underset{\text{Nitric Oxid}}{NO}$$

Second. The Nitric Oxid is permitted to unite with more Oxygen:

$$\underset{\text{Nitric Oxid}}{NO} + \underset{\text{Oxygen}}{O} = \underset{\text{Nitrogen Peroxid}}{NO_2}$$

Third. The Nitrogen Peroxid thus obtained is then permitted to react with water:

$$\underset{\text{Nitrogen Peroxid}}{3NO_2} + \underset{\text{Water}}{H_2O} = \underset{\text{Nitric Acid}}{2HNO_3} + \underset{\text{Nitric Oxid}}{NO}$$

PROPERTIES:

Physical.—1. Pure Nitric Acid is a colorless liquid with a specific gravity of 1.53 at ordinary temperatures. Strong aqueous solutions, as well as the pure acid, slowly decompose when submitted to exposure to light, forming water [H_2O] oxygen [O] and Nitrogen Peroxid [NO_2], the latter giving the acid a yellow color.

2. It is very poisonous and corrosive, possessing a sour tast, pungent odor, and acid reaction.

3. The pure acid is hygroscopic and rapidly absorbs moisture from air.

4. It is miscible in water in all proportions, and, like sulfuric acid, a rise in temperature is caused in the mixture, due to the contraction of the acid when mixed with water.

5. It boils at 85° and freezes at—47°.

6. It completely dissociates at about 256° into Water [H_2O], Nitrogen Peroxid [NO_2] and Oxygen [O_2].

CHEMICAL:

1. It reacts with most metals and nonmetals to form nitrats.

2. It reacts with most compounds, and turns animal matter yellow. It readily reacts with many organic substances, forming compounds of great importance. Thus, with ordinary glycerine it forms the compound known as Nitroglycerine, which is the explosive constituent of *dynamite*. Likewise, with cellulose, the principal constituent of wood-fiber, forms Nitro-celluloses, which are used in making *smokeless powder*. When Nitric Acid reacts upon Protein matter, a yellow compound known as Xanthorprotein is formed; hence when Nitric Acid comes in contact with the skin, a yellow stain is produced.

Nitric Acid is a strong oxidizing agent due to the large percentage of oxygen which it contains, and thus readily decomposes with evolution of Oxygen. Under ordinary circumstances, in the presence of a substance readily oxidized, the acid decomposes according to the equation:

$$\underset{\text{Nitric Acid}}{2HNO_3} = \underset{\text{Water}}{H_2O} + \underset{\text{Nitric Oxid}}{2NO} + \underset{\text{Oxygen}}{3O}$$

In such cases Oxygen is not evolved, but enters into combination with the oxidizable substances present. In this way Carbon, when heated with Nitric Acid, is oxidized to Carbon Dioxid:

$$\underset{\text{Carbon}}{C} + \underset{\text{Oxygen}}{2O} = \underset{\text{Carbon Dioxid}}{CO_2}$$

3. Practically all Nitrats are soluble.

4. It does not dissolve Tin [Sn], Antimony [Sb], Gold [Au] or Platinum [Pt]. It forms white powders with Tin and Antimony.

USES:

1. The chief uses of Nitric acid are to make Nitrats, Nitroglycerine, Nitrobenzine, Gun Cotton, Celluloid, to etch Zinc and Copper, and, in the laboratory, to prepare Aqua Regia, dissolve precipitates, and as an oxidizer. The most important nitrats are Potassium [K], Sodium [Na], Silver [Ag], Barium [Ba], and Bismuth [Bi]; also Nitroglycerine and Gun Cotton. The Potassium Nitrat is used as an ingredient of Gunpowder; the Sodium Nitrat in making Nitric acid; the Silver Nitrat in Photography, in analysis, indelible inks; Barium Nitrat is used in fireworks; Bismuth [$BiNO_3[OH]_2$] in medicine.

So far, in this series of articles, the writer has endeavored to make use of the simplest of apparatus, knowing that most experimenters have not funds sufficient to purchase more elaborate apparatus. In this installment we make use of a glass retort. This is essential to prepare this acid, and will be used again for the preparation of other compounds. For the benefit of experimenters who desire to equip a chemical laboratory on an economical basis, the writer heartily recommends the use of the apparatus illustrated in Fig. 75, which contains nearly all the apparatus necessary, with the exception of a few 8-ounce bottles, which can be purchased, or when an experiment calls for an 8-ounce bottle, ordinary jam bottles may be employed with good results. The apparatus shown may be obtained from several of our advertisers.

EXPERIMENT NO. 82:

Fasten on an iron stand, or tripod [Figs. 76 to 77] a large ring on which is placed an iron gauze or tin plate and asbestos. Above this fasten a clamp having three thumb screws, one of which grips the vertical rod, another the arm clamp, the third the tubulure of a 250 cc. glass retort having a sharply bent neck about 25 or 30 cm. long [Figs. 75a-75b]. Ring and clamp should be nearly parallel to the base of the stand, but the retort neck should run at right angles to it [Fig. 76], and reach within 3 cm. of the bench. Tightly fasten the three screws. The neck of the retort is then put into a large, clean, empty test tube, by lifting the entire stand and contents by the vertical rod with one hand and adjusting it with the other. Place the test tube in a wide bottle or tumbler, so as just to touch the bottom, readjusting the clamps if necessary. Fill the bottle or tumbler nearly full of water. Now raise the ring until the asbestos reaches the bulb of the retort, which should not be in contact with any metal.

Before charging the retort remove it from the tube by lifting the stand with one hand and taking out the tube with the other. Unclamp the retort by the screw. Pour into the retort thru the tubulure, from a creased paper [Fig. 78], about 10 grams of not too coarse Sodium Nitrat [$NaNO_3$], holding it with the stem slightly pointed upward so as to prevent any salt from lodging within the neck. Remove

(*Continued on page 285*)

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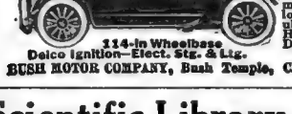

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QUESTION BOX.

(*Continued from page 271*)

is compared electrically by means of the standard.

Q. 2. Please give wiring diagram of such a simple method for measuring the capacity of a condenser?

A. 2. The diagram gives the wiring connections. The resistance arms of the bridge are represented by R_1 and R_2, while C_1 is the unknown capacity and C_2 the standard. The value of the unknown condenser is determined by the following equation:

$$C_1 = C_2 \frac{R_2}{R_1}.$$

ELECTRICAL ATTRACTION.

(817.) Lucius M. Turner, Royston, Ga., wants to know:

Q. 1. How to illustrate the experiment by which the laws of electrical attraction and repulsion are shown.

A. 1. There are several methods by which the laws of attraction and repulsion may be shown, and one of the simplest is by the use of the *electroscope*. A complete description of its construction and method of use for the experiment you desire has been illustrated in full on page 182 of the July, 1916, issue of THE ELECTRICAL EXPERIMENTER.

Q. 2. How to make a simple electro-magnet for use on 2 dry cells.

A. 2. A simple electro-magnet is made by winding several layers of insulated copper wire upon an iron core, as for instance, by procuring a four-inch carriage bolt about one-half inch in diameter and winding upon it six layers of No. 22 S. C. C. magnet wire.

POWER OF MOTOR.

(819.) William Jacoby, Bronx, N. Y., asks:

Q. 1. What determines the power given out by a motor?

A. 1. The power depends upon the pressure and current supplied to the motor, the current being regulated by the amount of work put upon the motor.

Q. 2. What causes the long flash when the field circuit is opened after the armature circuit is opened?

A. 2. This is caused by self-induction. When the current thru the magnet coil begins to drop, the magnetism begins at once to weaken. The change in the number of magnetic lines of force sets up or induces an E.M.F. that is in such a direction as to tend to maintain the current in the same direction, and at the same strength as before; the more rapid the change in the magnetization, and the larger the number of turns in the coil, the higher

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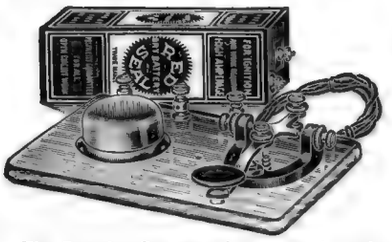

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WAVE LENGTH DETERMINATION.

(819-A.) C. King Davis, Hickman, Ky., desires to know:

Q. 1. How do you determine the wave length of instruments and aerials?

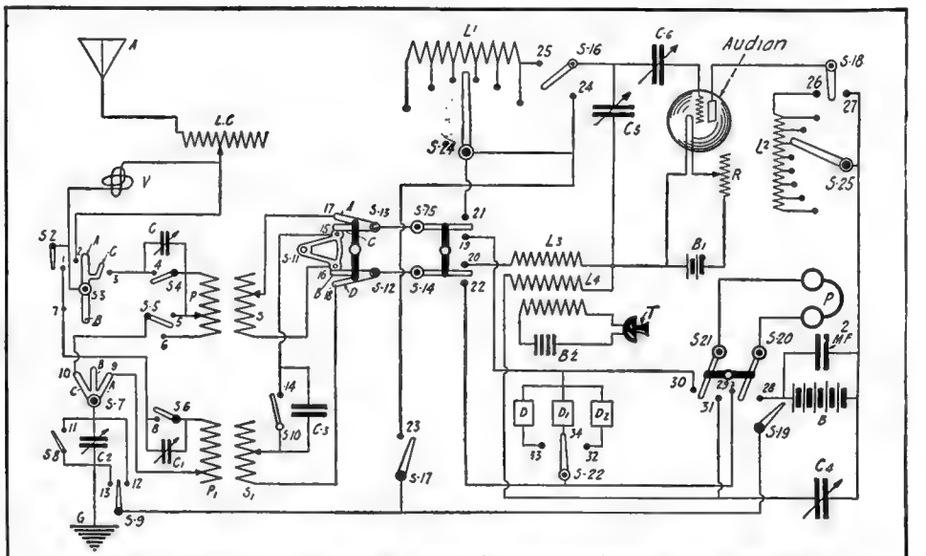
A. 1. Wave length of instruments and aerials are determined directly by means of a wave meter or by mathematical calculation if certain relations, such as dimensions, etc., of the instrument or antenna are known. These relations are substituted in definite mathematical formulæ which, when solved, will give the wave length of the instrument or antenna.

Q. 2. I have heard that amateur wireless stations have been prohibited until this present war is over; is this true?

A. 2. Yes.

MULTIPLE RADIO CIRCUIT.

(820.) H. S. New, West Orange, N. J., inquires:



L.C.=Aerial loading coil De Forest R.J. 11 2500-12000 M.
C =Variable condenser C1 =Variable condenser
C2 = .001 mf. Arnold Rotary, 21 brass plates or .000035-.001 Turney Vario Variable
C3 = Fixt condenser .006 mf. C4 =Variable cond.
C5 =Variable cond. .005 mf. C6 =Variable cond .0005 #124-A .00002 to .0007 mf. General Radio Co
V =Variometer De forest type R.J. inductance 200 M to 1500 M or Ayrton-Perry.. 107-A .015 to .25 Millihenrys General Radio Co. 107-B .25 to 4 Millihenrys General Radio Co.
P.S. =Long wave, 1#7 Arnold loose coupler, inductive tuner 11,000 meters.
P.S. =Short wave 1#5-A Navy type Receiving transformer 3500 M. Radio Apparatus Co
L1-L4 =1#5 Arnold loose coupler inductive tuner 3500 M.
D =Type BB Turney Crystalo detector
D1 =Liquid Barretter & Ronescon Crystal detector National Electric Sign'g Co.
D2 =L.W Austin Static Shunt Detector, Wireless Specialty Apparatus Co.
P =Brandes Navy type Phones 3200 ohms
De Forest V.C. 5-.0025 mf variable condenser
#101 M Variable air condenser .003 mf. General Radio Co.

Interesting Hook-up for Audion, Which May Be Operated As Interference Preventer, Heterodyne, Oscillating Audion for Generator, Amplifier for Crystal Detector, and deForest Radiophone Generator and Transmitter.

Q. 1. Would the diagram shown, by using the proper switches, be suitable for use as:

(a) Fessenden's *Interference Preventer*
(b) Fessenden's *Heterodyne* receiver
(c) Oscillating Audion for generator
(d) Amplifier for crystal detector
(e) De Forest Audion bulb as generator and transmitter?

A. 1. The circuit which you show was very ingeniously worked out and after careful examination, we find that it is satisfactory for accomplishing the results in question. It would be advisable to shunt a high capacity fixt condenser of 2 m.f. across the "B" or high tension Audion battery for reducing the impedance offered to the flow of the high frequency currents which are generated by the Audion when in an oscillatory condition.

CALIBRATION OF INSTRUMENT.

(821.) John Olsen, Jamaica, L. I., desires to know:

Q. 1. What do you mean when you speak of calibrating an instrument?

A. 1. The calibration of an instrument is the process of determining the value of the current or voltage required to move the indicator to any or all parts of the scale. This may be done either in making a new scale or in checking an instrument which has been in use. The calibration may, for example, be a comparison with a standard instrument or it may require the use or construction of new absolute standards.

Q. 2. For what range of resistance is the ohmmeter (megger type) suitable?

A. 2. It will measure resistances from about 5 megohms (one megohm equals 1,000,000 ohms) down to about 1,000 ohms. It is convenient for measuring the insulation resistance of wiring in houses that are not yet connected with the supply circuit, insulators, transmission line leaks, etc.

ROTATING FIELD PRINCIPLE.

(822.) V. R. Sullivan, Urbana, Ill., asks:

Q. 1. At the E. E. show at the University of Illinois, one of the magnetic freaks was as follows: a quarter (25c piece) was placed on a wooden base, somewhat concave, over a magnetic field consisting of three magnets, equidistantly placed, which was actuated by a three-phase current. When the current was on, the quarter given a slight start, would spin indefinitely, and the direction could be reversed at will. Please explain?

A. 1. The phenomena which explains the action of the rotation of the coin is identical to the fundamental principle of the operation of the A. C. induction motor.

As soon as the coin was started in a field of a three-phase current, currents are induced in the quarter, which reproduce a magnetic field in phase with the generated current and this field tends to follow in synchronism with the generated current, so that rotation is evident in the coin.

Q. 2. In the design of a rotary quenched spark gap as suggested by Dr. Zenneck, I believe it is necessary to revolve a wheel 30 inches in diameter at a speed of 14,400 r.p.m. This wheel may be made of either an insulator or a metal. The formula for centrifugal force is $f = \frac{m v^2}{r}$ and is correct for a weight on the end of a weightless string. What is the formula for determining the point of application of the force or the point corresponding to the center of gravity in such calculations? If I consider the entire weight of the wheel at the circumference, the results are impossible. You may consider the wheel as being made from a plain, unwebbed or unspoked wheel.

A. 2. You are entirely wrong in considering the rotation of a wheel for a rotary quenched spark gap at the velocity you state. It is necessary for such rotaries to be revolved at a maximum speed of 4,000 R.P.M., which is a normal speed for a wheel of 30 inches in diameter when properly balanced. There aren't any special formulae for computing centrifugal force and the equation which you give will hold true for a mass revolved at any speed, providing that the mass around the circumference is uniformly distributed.

SMALL HIGH FREQUENCY COIL.

(823.) E. E. Doherty, Dorchester, Mass., inquires:

Q. 1. What size wire should be wound on a small Tesla coil secondary, and how far apart should the turns be spaced from one another?

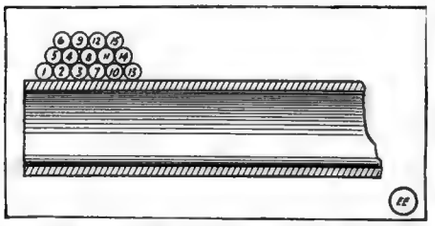
A. 1. The secondary coil should be wound with No. 28 D. C. C. magnet wire and each turn should be spaced from its adjoining turn by a 1/32-inch air space. It is advisable to wind between turns a thread which has been soaked with shellac or paraffin. This will prevent considerable leakage between turns.

Q. 2. Would the above coil work well on a one-inch spark coil?

A. 2. Yes. However, it is preferable that a two-inch spark coil should be employed.

Q. 3. About how many glass plates 4 x 5 inches would be needed for the condenser on a one-inch spark coil?

A. 3. Ten plates will be required.



How "Staggered" Windings Are Built for Radio Purposes So As to Reduce Distributed Capacity.

STAGGERED WINDING.

(824.) N. W. Smith, London, Ont., Can., inquires:

Q. 1. Please state what a *staggered* winding is?

A. 1. A staggered winding is a special method of winding inductance coils so as to minimize the distributed capacity of the coil due to its multiple layers. This method is employed considerably in winding multi-

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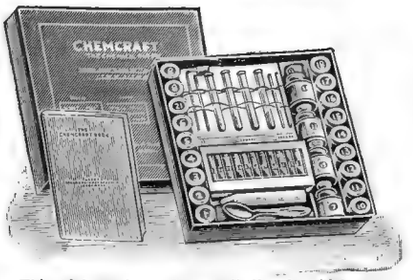

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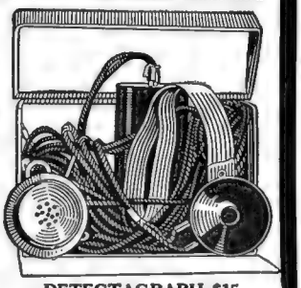

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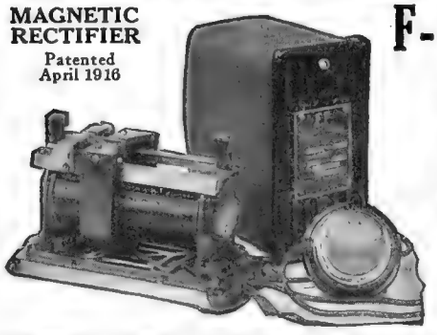

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layer coils for use in radio work. It is sometimes called "bank winding" and the manner in which the individual layers are wound is shown in a cross-sectional view given herewith. The numbers corresponding to each wire shows the exact manner in which it is related to the corresponding turns of the coil.

U. S. WANTS RADIO AUDITING CLERK, ALSO BOOKKEEPER AND ACCOUNTANT.

The United States Civil Service Commission announces open competitive examinations for auditing clerk (radio) and bookkeeper and accountant (radio), for men only, on July 25, 1917. Five vacancies in the position of auditing clerk at entrance salaries ranging from $1,000 to $1,400 a year; one vacancy in the position of bookkeeper and accountant at $1,500 a year; two vacancies in the position of assistant bookkeeper and accountant at $1,000 a year, all in the office of Naval Communication Service, Washington, D. C., and future vacancies requiring similar qualifications, will be filled from these examinations, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion.

The duties of the position of bookkeeper and accountant involve the necessary bookkeeping work in connection with both Government and commercial traffic handled by the Naval Communication Service thruout the world, including disbursements to domestic and foreign Governments for such traffic.

Applicants must state in answer to Question 1 of the application form which of these examinations they desire. Only one of these examinations may be taken by the same applicant.

Applicants for the position of auditing clerk must show that they have had at least six months' experience in auditing radio, telegraph, and cable accounts in connection with a communication service involving all three methods of communication. They should be familiar with laws, regulations, and rates pertaining to radio telegraph and cable communication thruout the world. It is desirable that they be able to operate a typewriter.

Applicants for the position of bookkeeper and accountant must show that they have had at least six months' experience in bookkeeping and accounting work in connection with radio, telegraph, and cable traffic, and they should be familiar with the laws, regulations, and rates pertaining thereto.

Applicants must have reached their twenty-first birthday on the date of the examination.

Applicants must submit to the examiner on the day of the examination their photographs, taken within two years, securely pasted in the space provided on the admission cards sent them after their applications are filed. Tintypes or proofs will not be accepted.

These examinations are open to all male citizens of the United States who meet the requirements.

Applicants should at once apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C., or to the secretary of the United States Civil Service Board at any duly appointed place. Applications should be properly executed, excluding the medical and county officer's certificates, and filed with the Commission at Washington in time to arrange for the examination at the place selected by the applicant. The exact title of the examination desired, as given at the head of this announcement, should be stated in the application form.

For further information address U. S. Civil Service Commission, Washington, D. C.

THE RADIO BOMB.

(*Continued from page 247*)

And then he knew—

Deep, rumbling and sinister, it was the roar of the river straining sullenly at the prison of ice which confined the rush of water coming down from the tributaries far up in the hills.

As he drest hurriedly, he glanced out the window and saw to his surprise that where there had been deep drifts of clean white snow, the evening before, there were now vast stretches of muddy earth criss-crost by rivulets of yellow water running to the swollen river. Evidently the south wind had done its work well.

Hastening down stairs he found his father pacing the length of the kitchen with quick nervous strides.

"Is it very bad, Dad?" Dick asked.

"Yes, I'm afraid it is, Son," his father replied anxiously. "The river's so high I'm afraid the ice'll go out any minute and—"

"Joe—oh, Joe!" loud voices summoned imperatively, and following his father Dick past out into the store from which the cry had come.

"What do you want?" the elder Preston asked, as he threw open the doors and confronted the group which stood outside.

Glancing past him, Dick saw in astonishment old Tom Waldon at the head of some dozen men armed with shotguns, rifles and revolvers ominously ready for use.

"Are you comin'?" Waldon demanded, opening his coat so that the constable's star could show to even better advantage.

"Coming where?" Joe Preston asked in surprise.

"To get that spy!" old Tom retorted.

Wide-eyed and face pale, Dick stared in amazement at the old constable and his posse. Did they really mean to attempt the capture of Captain Hardy? Did they mean to apprehend him simply because of their suspicions? The grim intentness of men and weapons left no room for doubt.

"Did you get your search warrant?" he managed to stammer out huskily.

"We ain't got time for no search warrant!" old Tom shot back. "Didn't you hear that bomb last night?"

"I thought I heard some one shoot," Joe Preston replied.

"Well, I reckon you did," the old man cackled, ironically. "I'd been blowed to pieces if I'd been fifty yards closer to that pile o' drift down there on the bend when it blowed up. The pieces fell all around me just as I was goin' home. Are you a'comin'?"

"But I don't see—" Joe began.

"Look here, Joe Preston," Pete Bailey burst out. "Are you goin' to stand by and let that spy blow up our houses? that's what'll be next. Tom's right. We'd better get him right now a'fore he gets a chance to do somethin' else."

"And that's what I think too," a half dozen endorsed.

"Better come along a'fore I have to deputize you," old Tom advised with a threat in his tone.

Cheeks pale and eyes staring in apprehension, Dick saw his father gaze in perplexity at the grimly armed group before him.

"I—" Joe began.

His words were lost.

With a roar like the broadside of a mighty battleship, the ice of the river shot skyward in a mad jumble of huge leaping cakes, only to fall back in a crashing grinding mass and be swept crunching and splintering down the stream on the crest of the yellow water, as it raced at whirlwind speed down the channel so suddenly freed.

Paralyzed by the shock the group in front of Preston's store stared in bewilderment at the plunging rocking mass as it surged wildly down the stream with a terrible deafening din.

And then, as one man, they turned in terror to the gorge.

They had cause for terror, for there, between the high banks, the ice had jammed in a solid immovable barrier squarely across the stream's channel.

As the group stared open-mouthed in paralyzed inaction, it grew swiftly, towering higher and higher as the swirling waters from above swept down fresh masses of ice to be piled cake on cake as the obstruction mounted steadily skyward. Higher and higher it reared itself and higher and higher rose the foaming yellow waters behind it, striving in vain to thrust aside the obstacle which blocked its path.

If it should triumph, if the swiftly widening lake behind the jam should sweep down on the little clustered hamlet— The group in front of Preston's store knew just how long their houses would survive that rush.

"Dynamite! Dynamite!" Pete Bailey shouted, and a half dozen men leaped toward the shack where Joe Preston stored his supply of the explosive.

But even as they leaped they knew that no man could live in that heaving tumult long enough to place a charge where it could blast the steadily mounting obstruction from the channel.

"The hills! Run to the hills!" they shouted, and around the store and up the muddy slope they fled to the first steep knoll where the women and children had already gathered at the first thundering break of ice.

But Dick Preston did not run. For a long moment he stared, fascinated at the wall of ice which towered in the gap restraining the impending wall of water. If that jam could not be broken before the water surged thru with its own mighty strength, he knew just how short would be the life of this little village, his home. But who could—

He whirled, dashed thru the store and sprang up the stairs to his room. At his wireless table he halted, jammed the receivers down over his ears, while his fingers slammed in switches and connections.

Then with savage speed his key tapt out, "H D, H D, H D, D P," the crackle of the spark sounding dimly weak thru the deafening roar of ice and water outside.

Again he repeated the call with frantic speed and threw over the aerial switch.

"O K, D P, H D," came the reply, barely audible thru the din.

"Ice has jammed in gorge. Can you—" the white hot spark faltered and then failed.

With a choking sob Dick peered over his instruments, trying wildly to locate the trouble. Then thru the window he caught sight of his aerial wires sagging limply along the ground where they had fallen when a guy wire peg had slipt.

"Dick! Dick! Where are you, Dick!" he heard his father calling in agonized tones, and snatching the receivers from his head he sprang up and dashed downstairs to meet his parent leaping up in search of him.

"Hurry! Hurry! It'll go any minute!" Joe Preston implored and together father and son raced up the muddy slope to the knoll where the population huddled in a forlorn hopeless mass.

Would he understand? Had the grounded aerial made his message unintelligible? Over and over Dick asked himself while he sped to safety.

At the gorge he looked and saw the ice wall still mounting higher while the water restrained behind it spread wider and wider in a huge menacing lake.

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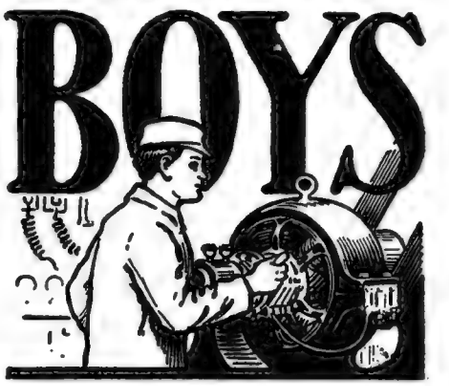

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Electric Machine Designer	ILLUSTRATOR
Telegraph Expert	DESIGNER
Practical Telephony	BOOKKEEPER
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Mechanical Draftsman	Cert. Pub. Accountant
Machine Shop Practice	Railway Accountant
Gas Engineer	Commercial Law
CIVIL ENGINEER	GOOD ENGLISH
Surveying and Mapping	Common School Subjects
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STATIONARY ENGINEER	Textile Overseer or Supt.
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Then with a prayer on his lips, he lookt eastward toward the mist-hidden bulk of Pine Mountain.

In an agony of suspense he scanned the blurred clouds and after an almost endless moment, caught the darker and distinct outline of an object high up in the heavens.

For an instant it appeared but a blotch against the mist. And then shaking free the vapor it shot out into the clear sunshine, a slimly cylindrical shape, the sunlight glittering from its two pointed ends as it glided at terrific speed thru the air a thousand feet above the earth.

"Look! Look!" Dick gasped, and pointed.

Straight as an arrow the uncanny thing came, showing momentarily a glimpse of a humming propeller on the tiny car which drove it forward without the presence of a man. Then into the cloud of mist which hung high above the gorge it dove and was lost to sight.

But even as it dove a huge column of spray spouted skyward from the jam to join the hovering mist-cloud, and an instant later a series of six rapid reports boomed out even above the roar of ice and water.

A minute afterward the mist drifted clear of the gorge and there—where had been the towering ice barrier, the people of Pine Flat saw the river, yellow, swift and turbulent to be sure, but running free and clear thru the gap and down past the hamlet, with a wide margin of safety between water and buildings.

* * * * * * * *

"You couldn't have placed them more accurately with gunfire!" Dick cried enthusiastically. "Why they were right where they needed to be!"

"I'm glad," the tall man in overalls beamed happily. "I was a bit afraid of the control. But I'm ready to announce results now."

"I've already—"

Dick stopt in amazement as the door of the cabin swung back. In the opening stood old Tom Waldon, mud-smeared, bedraggled and wet but strangely humble; while at his back crowded the men of Pine Flat, pushing their way inside.

"Captain Hardy?" old Tom inquired deferentially.

"Yes," Hardy acknowledged, returning the stiffly queer salute the old man gave him.

"We've come to tell you," the old constable said, "that we're mighty thankful to you for savin' us by blowin' that ice jam out o' the gorge. And more'n that we want you t' know we never would've thought you was a spy if you'd let Dick Preston here tell us that you was a United States signal corps officer inventin' that airship that dropt them bombs by wireless."

PERPETUAL MOTION.

(*Continued from page* 249)

ing in the oil. But try as we might, the rinktum wouldn't budge. Another bright idea—a few batteries, connected to the dynamo to "start her off." Once she runs we take the batteries off, and the system will run under its own power. No sooner thought than done. We fetched the 8 volt storage battery and hooked her up! And by jove it worked! Ran fine, and fast too. But alas, as soon as the storage battery was taken off, the newly wedded motor and dynamo had a private disagreement. Both became as obstinate as mules—or shall we say as a newly married couple, on their first (and subsequent spat)—and refused to budge.

After that several other schemes were

tried out, but none of them could be classed as even a tolerable success. Of course, no one was charitable enough in those days to inform us that in the transformation of energy from dynamo to motor, and in turn from motor to dynamo, we lose about 20% of our total energy, which being 100%. And 20 from 100 leaves 80%. And you can't buy a dollar for 80 cents—at least not thru the cashier's window.

But ignorance is bliss. So the other day while rummaging thru old papers, the Editor came across "Experiment 79, not tried out—looks *positively* feasible." Experiment 79, by the way, was one of the series of schemes to make the above, painfully described rinktum work. And if we do say it ourselves, for a scheme evolved by an 11 year old school boy, it is positively *épatant, extraordinaire,* as our French teacher would have said, pride oozing out of him by the handful, while he spoke.

But alas we never had the money to try it out. And what's more, we haven't got it now. And the way things look with the war, the H.C.L., and the cost of high living, there's no telling that we will ever get a crack at it.

But your Editor, who is far famed for his vast generosity (when his own pocketbook is not concerned) graciously donates his great and wonderful "Experiment 79" to all Bugdom. Anyone may try the scheme, and there is only one string attached to the offer, to wit:

In case it works, the Editor is to get a free ride at least once a week! Now that's modest, isn't it?

Well here's "Experiment 79."

Build a scenic railroad in a complete circle, as shown in illustration. Hills and valleys—the more the better—just like the regular scenic railroad. Now we know as a fact that a car launched on such a road will run the entire length of the track—almost, that is, it will *almost* come back to its starting point. But not quite. Now here's where the foxyness of the idea crops out:

While coasting down hill, the car expends a lot of useful energy. So let's harness it! We simply install a dynamo in the car, coupled to the axle of the latter. Use a third rail to convey the energy to a central storage battery. So we see that while the cars coast, we accumulate a lot of surplus energy. *Also the more cars used, the more energy we get.* That's plain.

Now then. As the car comes up the home stretch it runs slower and slower, and finally reaches a stage where the dynamo, which is "floating on the line" gives forth no more energy into the line. At this point the storage battery begins to discharge into the dynamo and the latter then must run as a motor. No electrical engineer will deny this fact. So the motor fed from the storage battery will pull up the car over the crest, and the play commences anew. If there's no hitch anywhere, the car will keep on running till the tracks are worn out!

Sounds perfectly logical, doesn't it? Now why in Sam Hill don't it work?

EXPERIMENTAL PHYSICS.

(*Continued from page* 250)

the pole. He will likewise sit down on mother earth in great haste. (It may be advisable at this stage of the experiment for you to retreat.)

EXPERIMENT 34 (See Fig. 26)—Place a card on a table with part of it projecting. Place a coin on the card. If now the index finger is rapidly snapt against the protruding end of the card, the card will fly off and the coin will tend to remain at rest and drop directly underneath. With a little practise one may acquire skill and can place the card on one of the fingers of the other hand and perform the same experiment.

EXPERIMENT 35 (Fig. 27)—This represents a little Mexican game (not the game of throwing the bull) which can be purchased in the five and ten cent store. It consists of five blocks in the shape of checkers, together with a wooden head, and a wooden hammer of slightly smaller diameter than the blocks. With a swing of the hammer G, block B is sent flying and head A drops on block C. In the same manner blocks C, D, E and F, are removed. Obviously the tendency of the blocks to stay at rest makes this game possible. Later one can learn to skip a block and try to knock off alternate ones. Finally it becomes possible to knock off block F, without the rest of the pile being disturbed.

EXPERIMENT 36—So far we have considered only part of the First Law. The fact that mud flies off a bicycle wheel tangentially leads up to the consideration that bodies tend to maintain not only the *amount,* but the *direction* of motion. It is *inertia* that keeps the water from falling out of the pail when swinging it over one's head. It is *inertia* that makes it possible for us to loop the loop in the scenic railway at the amusement parks. *Inertia* causes rotating liquids to move out as far as possible from the axis of rotation; it makes flywheels burst sometimes; it makes the diameter of the earth at the equator greater than at the poles; it makes the milk which is heavier than the cream move out farther in the cream separator. It causes the loop of cord A to assume the position B, or a perfect circle (Fig. 29), when rotating the cord rapidly. This is the underlying principle of the cowboy's lasso. An egg (good or bad) provided it is not a hard-boiled egg, after having its insides sucked out thru a pin-hole, has a string attached to one end by the aid of a piece of sealing wax. If now the string is twisted rapidly so that the egg rotates rapidly, it assumes the position B because of *inertia.* (See Fig. 29.)

EXPERIMENT 37—If an automobile engine exerts 4,000 pounds pull on an engine on a level road, at the end of one second the velocity acquired would be just twice as great as if the engine exerted a 2,000 pull. In view of this fact, Newton's second law could be stated—The rate of change of momentum takes place in the direction in which the force acts and is proportional to it.

Space does not permit giving anything but this very simple experiment. (See Fig. 28.) By means of thumb tacks attach two pieces of thread to a base ball and suspend it as shown. If the thread is grasped at A and pulled suddenly it will break between A and B. If, however, the experiment is repeated, pulling *slowly,* the thread breaks between C and D.

EXPERIMENT 38—If a small "Little Hustler" motor fan is placed on a light wagon (Fig. 30) with ball-bearing wheels and a board is placed in position A, then when the fan is started nothing unusual happens. If, however, the board A is removed, our little wagon moves toward the right. Every action has an *equal* and *opposite reaction,* and hence when the fan pushes against the air in front of it, the air pushes back and if the wagon is light enough and the friction at the wheels is small, the wagon moves.

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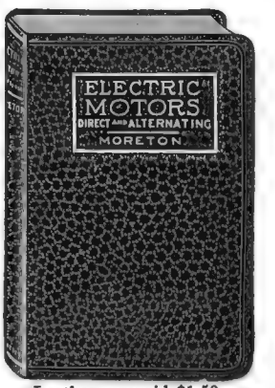

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When the board A is in place the wind from the fan pushes against it, but since both the board and the fan are attached to the same wagon, no motion occurs. On a calm day, if motoring rapidly, we feel a wind. Our pushing against the air causes the air to push against us and we get the sensation of wind. The aeroplane is propelled by the reaction of the air against the wind made by the propellers.

In the case of a man rowing a boat, the man pushes against the oars, the oars against the water. The *reaction* of the water against the oars is transmitted to the boat, and it moves. When one jumps off a boat, the boat experiences a backward thrust. When a bullet is shot from a gun or a shell from a cannon, the gun "kicks" or the cannon is pushed back by the reaction. If the two bodies considered are of the same mass the *action* and *reaction* are easily seen to be *equal in magnitude,* but otherwise it may be difficult to see it at first consideration. We must remember that the quantity of motion is in each case the product of the mass by the velocity.

The importance of Newton's laws cannot be overrated, and examples of their application can be found without end. It is suggested that the reader look about him for as many examples of each as he may recognize. The writer will be glad to correspond with those further interested in this subject.

"BATS."

(*Continued from page* 261).

the top of a cloth bag of dropsical shape and knobby surface, could be truly loved for its appearance by its maker only; but it worked perfectly, and faithfully gave up its little trickle of "juice" for the operation of our apparatus. What should we ever have done without it?

Of course, like all worldly things, it had its faults. Sal-ammoniac is harmless to the human system (unless you happen to get it on a cut, when it makes you execute a few capers and forget your other troubles) but its appetite for copper is unlimited, and its cunning hygroscopic habit of creeping out of the jar and spreading itself over the surrounding landscape does not endear it to any member of the family, from the cat up. On returning from a summer vacation, I have more than once found my copper terminals eaten off and forming the center of a spongy mass of a beautiful grass-green color, while everything within several feet was covered with the damp white deposit of sal-ammoniac crystals. I always longed to try the experiment of setting one of these batteries in the midst of a boundless plain and seeing how far one jar-full of the stuff could spread itself if it had plenty of time and room; I believe it would cover the earth.

While the Leclanché battery was always our standby, it had its limitations. Its resistance was high, its current of small quantity, and on being short-circuited it promptly polarized and died. We tried Bunsen's, but they were far too expensive. But with the coming of the telegraph era, we took up gravity cells, and they soon secured a warm place in our hearts. These sturdy cells worked 24 hours a day, as long as the slightest color of copper sulfate remained in them. We were never tired of noting the clean-cut line of the blue solution, held in its place at the bottom of the jar by its excess weight over the transparent solution above—a difference, of course, not apparent to the eye.

This battery piqued our inventive faculty because it furnished so much more current than we needed. Not only when we were using the telegraph, but all the time when we were at school, or in bed and asleep, it plugged away. If one could only economize it! but it was impossible. If the circuit was left open, the blue solution rose by diffusion till it directly attacked the zinc, when mud and long strings of copper metal began to form, and soon the battery was ruined. Neither could you economize by lifting out the zinc, because again the diffusion took place, and you couldn't put it back without raising all sorts of chemical Cain.

No use; we had to stand by and see all that beautiful "juice" wasted while we needed it elsewhere. It manufactured more in one day than the Leclanché cell did in its lifetime, yet it was useless because it couldn't be held back. Even the similar Daniell cell, with its porous cup, couldn't be left on open circuit; it was necessary to use up the copper sulfate on its depolarizing job faster than it could spread by diffusion. All the text-book writers said there was no help for it.

But text-book writers have never been boys!

When clocks came in, the demand became still more pressing. Here was a mechanism which required but little current, to be sure. A wet Leclanché would run it for months; but that only made the gravity cell, in its obstinate generosity, more exasperating. A gravity cell would run three months on one charge of sulfate, producing in that time enough current to run the clock for 60 years at the lowest calculation. If one could only choke it back!

Fools rush in where scientists are afraid of getting the laugh. In spite of the text-book writers, Dr. Daniell and the Lion's Den, I puzzled over ways to strangle up that cell.

It first struck me to confine the sulfate solution in a non-porous cup, and let it ooze out over the copper plate thru a very small hole, instead of exposing a great area

(*Continued on page* 284)

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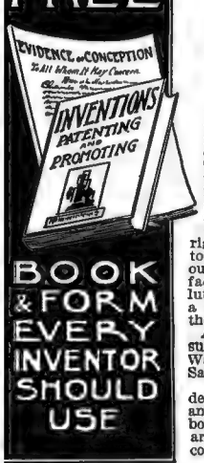

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Edited by H. GERNSBACK

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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

DETACHABLE HEEL.

(166.) Joseph Pacyk of Glassport, Pa., submits to us a very ingenuous idea whereby an ordinary leather heel on a shoe can be detached when it is worn out, in a very simple manner thereby making it unnecessary to take the shoes to the shoemaker or repair shop. His idea is to get the shoe people to stock these special heels, which can then be attached by any one without any tools whatsoever.

A. This is a capital idea, and no doubt a patent can be obtained. In case nothing similar has been patented before, and we doubt there has, we think a valuable patent may result. We would advise our correspondent to get in touch with a patent attorney.

Mr. Pacyk also submits to us a design of a tooth brush, the idea being that it could be used for brushing teeth on the inner side of the teeth as well.

A. We do not think this idea is patentable, and we believe several brushes similar to this one have been in use.

SUBMARINE MINE.

(167.) Elmer Wahl, of Carnegie, Pa., encloses diagram and description of a self-exploding mine for harbor defence. The mine is supposed to explode when a submarine comes in proximity to it. The principle is based upon a highly magnetized needle which the submarine is supposed to deflect, and then auxiliary contacts cause the explosion of the mine, or otherwise the current for the mines may be supplied from the shore; thus, doing away with the batteries in the mine itself.

A. We do not favor the first idea at all, as it is not practical, being too dangerous; *i.e.*, the mine might explode prematurely if a friendly steamer came into range. The second idea is not new. The United States Navy is using similar mines controlled from shore. We cannot give any encouragement on these two ideas.

GAS SPARK GAP.

(168.) Harry McLaughlin, Jr., Pawhuska, Okla., has made some experiments with a bunsen burner and spark gap, and found that by means of the bunsen burner, the spark can be lengthened out several times its original value. He wishes to know if this is a new discovery and whether the idea is patentable. Also if it is to any advantage in some form of electrical apparatus, wireless, etc.

A. Nothing new is suggested in the device, which is old. If you take an ordinary candle and spark gap, and let the spark go across the lighted candle flame, the spark will be lengthened considerably. The reason is that all flames contain large amounts of hydro-carbons, due to the combustion of carbon or whatever other materials are burnt up, and these carbon particles as well as the hot air form a much better conductor than the common atmosphere. This is the reason why the spark is lengthened out considerably. There is nothing new in this experiment, which has been performed by various physicists over 100 years ago.

SELLING PATENTS.

(169.) Fred Jeffries, Passaic, N. J., wants to know the best place to dispose of a patent. Mr. Jeffries is an electrician and has a patent on an electrical device which he desires to dispose of.

A. THE ELECTRICAL EXPERIMENTER cannot officially give the names of persons that are likely to buy electrical or any other patent. The safest and best way is to advertise an illustration of the patent drawing in our advertising columns or otherwise in local newspapers. It might also be a good idea to send copies of the patent to advertisers in THE ELECTRICAL EXPERIMENTER who make a specialty of manufacturing electrical appliances.

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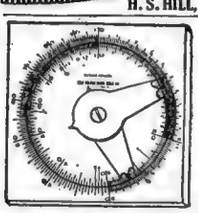

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"BATS."

(*Continued from page 282*)

of it to diffusion. That sounds reasonable, doesn't it? Well, here's what happened.

I set up a cell as shown in Fig. 1, my glass sulfate-storage cup "S" having a hole about ⅛" diameter drilled thru the bottom. That seemed to me pretty small, but bless you, it was as wide as a barn door for that elusive sulfate. On open circuit it serenely diffused out as tho my cup had been composed entirely of hole.

This sulfate was evidently an animal that had to be stalked with care if one wanted to capture it. I cleaned out my storage-cup, and in the bottom, over the hole, I placed a dozen discs of filter-paper. "Now," says I to the sulfate, "tackle that little obstruction and see what you make of it, dog-gone you." Another surprise: Mr. Sulfate sulked and refused to emerge at all. I was tickled to death at first, because I needed hardly any of it for an open-circuit proposition, and it looked as if I had it strangled good and plenty for the purpose; but as days went by and no sulfate appeared without, I concluded I had it choked too much. "Well and good," says I, "I've got you down, now I'll let you up slow." So one by one I removed my filter-paper discs until only a single one was left, and what do you think? That one was just as good, or bad, as the whole dozen! In the open air the blue solution would go thru nicely, but against the pressure of the surrounding liquid it wouldn't budge!

I wasn't disappointed; in fact I was rather pleased, because all I had to do was to continue my cautious stalking. I took a fine needle then and pricked just one little hole in the filter-paper. "Now," says I to Mr. Sulfate, "there's a place you can crawl thru, and I'll slowly enlarge it till you can get your head out, but no more, so don't you tease!"

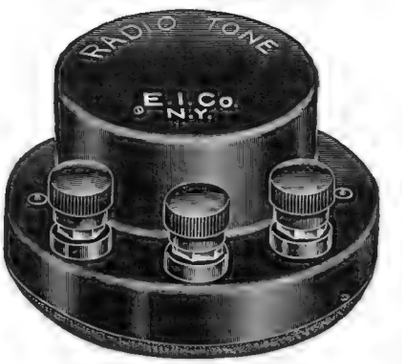
Is that so? I heard what I thought was a gurgle in the battery, but it was Mr. Sulfate giving me the grand high chuckle. He came out of that needle-hole as easily as I could get out of the State of Massachusetts (if I wanted to, that is; of course no one would ever want to do a thing like that). It was evidently either one extreme or the other with Mr. S., and that choke-valve theory had to be abandoned.

All this time my battery, electrically, worked to a charm, and I could see plainly that the only problem was controlling my supply of sulfate. My blue-colored friend had shown considerable ability in crawling out thru the cellar, but could he climb out the chimney? I plugged up the hole in the bottom of my storage-cup, and offered him a passage instead thru the *siphon* shown in Fig. 2.

I can't remember whether the sulfate did diffuse thru the siphon or not; I think it did; but the chief trouble was that bubbles of gas collected in the top of the siphon and eventually broke the liquid connection. The next step was to discontinue the siphon as a siphon, and fill it with cotton wicking, so that a connection between the two liquids was maintained by *capillarity*.

This at last was successful. The liquids did not mingle at all, while the hydrogen atoms still had opportunity to travel, as they must, from the zinc to the copper plate. My battery gave a nice little current—very slight in quantity, of course, on account of its high resistance, but of good voltage. It would stand any length of time on open circuit without mixing, while if put on closed circuit it would get busy all-same bee, as Charley One-Lung would say, and stick to its job as long as required.

The problem was now, while preserving the same principle of capillarity, to reduce



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the *internal resistance.* The final form to which I carried the cell is shown in Fig. 3. This is like Fig. 2, except that the capillarity is secured thru several layers of burlap sacking, straddling the *entire* edge of the inner cup. This reduced the resistance to a point where the electric output was sufficient to work a swinging-magnet annunciator-drop very well.

Munn says the idea is patentable, but none of this patent stuff for mine. I hereby turn the invention over to Bugdom for improvement. If such a form can be given it that the capillary mass is very much larger, it will give an output big enough for a clock; at present it doesn't, but is ample for any high-resistance indicating device, electrolytic detectors, etc. As to its staying powers, I had one of these cells on open circuit in my shop for *four years,* testing it with the annunciator-drop from time to time. At the end of the period the liquid had evaporated out by a half, owing to my cover not being perfectly tight; but the zinc plate was very little consumed, the liquid in the outer jar was as clear as spring-water, the blue solution remained in the inner jar with no diminution in the sulfate crystals I had added to keep it saturated. The current would still work the annunciator-drop, tho not as vigorously as at first, probably due to the liquid levels being lower. I had to leave the old house then, and as the battery couldn't be moved the experiment was over.

Why don't you push it along, Bugs, just to while the time away till they give us back the air? That "bat's" a handy little thing as it is; and if you could devise some low-resistance form that you could couple on to a clock and run the thing 5 to 10 years at a stretch—well, s-ay!

EXPERIMENTAL CHEMISTRY.

(*Continued from page 274*)

also, by the finger or towel, any nitrat adhering to the tubulure, as it is liable to crack the retort on heating. The retort may now be readjusted in position. Pour into a tube about 20 cc. of strong Sulfuric Acid [H_2SO_4], and using a glass funnel, so as to keep the acid out of the retort neck, pour it into the retort. Rinse the funnel, replace the stopper in the tubulure, and readjust the retort in position. Apply heat for 10 or 15 minutes, or until 5 cc. or more of liquid has collected in the test tube.

Upon the introduction of the Sulfuric acid into the retort, action will probably commence at once, but a gentle heat should be applied, whereupon the volatile Nitric Acid passes over and is then collected in the test tube in the bottle or tumbler, which should be kept cool. A few pieces of ice may be placed in the water.

The reactions which will probably take place are:

$$\underset{\text{Sodium Nitrat}}{NaNO_3} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Sodium Hydrogen Sulfate}}{HNaSO_4} + \underset{\text{Nitric Acid}}{HNO_3}$$

or

$$\underset{\text{Sodium Nitrat}}{2NaNO_3} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Sodium Sulfate}}{Na_2SO_4} + \underset{\text{Nitric Acid}}{2HNO_3}$$

The reason for these two equations are more fully explained under the heading "Preparation" in a previous paragraph.

Note all phenomena, fumes, color, whether or not the color changes with varying temperature, effervescence, whether anything is visible in the retort tube, color of the liquid collected, etc.

As soon as the lamp is removed, pour 5 or 10 drops of Ammonium Hydroxid [NH_4OH] into a dish and dip a small piece of paper or stirring rod into it; then bring the alkaline paper or rod to the tubulure, removing the stopper with a cloth if it is hot. This must be done while the contents of the retort are hot.

Note any action and fumes [whether gaseous or solid].

To remove the collected acid, which should be done soon after the lamp is taken away, lift the entire ring stand with one hand and with the other grasp the test tube by its rim between the thumb and forefinger and set it in the rack. [Use great care at all times not to get any of this acid on the flesh or clothing, as it is very corrosive. Let down the ring stand in such a position that any acid may drip from the nozzle into the sink; then raise the retort to a horizontal position by changing the clamp screw. Put a funnel into the tubulure and pour water thru it into the retort bulb [cautiously at first, if it is hot, and from a tube]. Finally clean the entire retort, running water several times thru the neck, bulb and tubulure.

EXPERIMENT NO. 83:

Note the color of the liquid obtained in the preceeding experiment, and if you have some of the commercial acid at hand, compare with it in this respect.

Apply a piece of litmus paper to the liquid thus obtained in the preceding experiment, and if an acid is present it should give an *acid reaction* with the litmus.

Obtain a piece of colored cloth [woolen] and permit a few drops of the acid to fall upon it. Dense fumes should rise from the cloth, and the cloth become discolored, as tho rotten. From this it is obvious what would occur if this acid were to come in contact with one's suit or other cloth; thus it is obvious that great care should be exercised not to permit it to spill.

With a glass rod put a drop of the liquid on a quill, a feather or a piece of white silk; also place a drop on the finger nail, but wash it off at once. Note any change in the color of these substances. Pour into a dish a few drops of ammonium hydroxid [NH_4OH] and, using the rod, put a drop of this on the places just touched with the acid, noticing whether the color is intensified or reduced.

Dip a splint and a narrow strip of paper into your liquid, dry them, and then set them on fire, noting how they burn.

EXPERIMENT NO. 84:

Put a few pieces of copper clippings into a dish and pour over them some of the acid obtained. [This is the same experiment as No. 28 in the January, 1917, issue of the ELECTRICAL EXPERIMENTER, page 666]. In Experiment No. 28, it was stated that hydrogen was not liberated by the inter-action of Copper and Nitric Acid, the equation being:

$$\underset{\text{Copper}}{3Cu} + \underset{\text{Nitric Acid}}{8HNO_3} = \underset{\text{Copper Nitrat}}{3Cu[NO_3]_2} + \underset{\text{Water}}{4H_2O} + \underset{\text{Nitric Oxid [Note]}}{2NO}$$

[NOTE.—In Exp. 28 this was given as Nitrogen Monoxide].

As we did not take up the reason why Hydrogen is not liberated when Copper is reacted upon by Nitric acid, and this paper deals with the acid, it will not be out of place to show why the Hydrogen is not liberated.

When moderately dilute Nitric acid [density 1.2] acts upon copper, the reaction may be exprest by the following equations:

$$\underset{\text{Nitric Acid}}{2HNO_3} = \underset{\text{Water}}{H_2O} + \underset{\text{Nitric Oxid}}{2NO} + \underset{\text{Oxygen}}{3O}$$

$$\underset{\text{Oxygen}}{3O} + \underset{\text{Copper}}{3Cu} = \underset{\text{Copper Oxid}}{3CuO}$$

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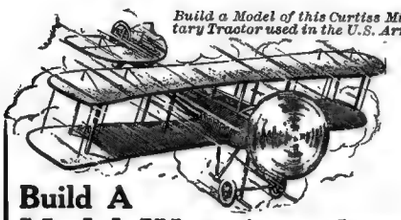

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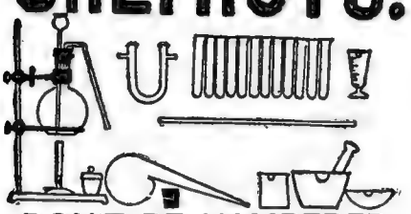

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$$3CuO + 6HNO_3 = 3Cu[NO_3]_3 + 3H_2O$$
Copper Oxid + Nitric Acid = Copper Nitrat + Water

By cancelling the factors 3O and 3CuO, representing substances formed in one reaction and used up in another, and combining these three equations, the following equation is obtained:

$$3Cu + 8HNO_3 = 3Cu[NO_3]_2 + 2NO + 4H_2O$$
Copper + Nitric Acid = Copper Nitrat + Nitric Oxid + Water

If concentrated acid is used in place of dilute, Nitrogen dioxid is liberated, as shown by the following equations:

$$2HNO_3 = H_2O + 2NO_2 + O$$
Nitric Acid = Water + Nitrogen Peroxid + Oxygen

$$Cu + O = CuO$$
Copper + Oxygen = Copper Oxid

$$CuO + 2HNO_3 = Cu[NO_3]_2 + H_2O$$
Copper Oxid + Nitric Acid = Copper Nitrat + Water

Combining these into a single equation, we obtain the following:

$$Cu + 4HNO_3 = Cu[NO_3]_2 + 2H_2O + 2NO_2$$
Copper + Nitric Acid = Copper Nitrat + Water + Nitrogen Peroxid

Hydrogen is not evolved at the same time, as in the case with Sulfuric Acid and Hydrochloric Acid, but in its place lower oxids of Nitrogen and even Nitrogen itself and Ammonia are formed. The explanation frequently given of this change is that hydrogen is first produced, but that it at once acts on the excess of Nitric Acid present, forming water and the lower oxids of Nitrogen. Thus, the formation of nitrous oxid by the action of Nitric Acid on Copper is supposed to take place in the two following stages:

$$Cu + 2HNO_3 = Cu[NO_3]_2 + 2H$$
Copper + Nitric Acid = Copper Nitrat + Hydrogen

$$6H + 2HNO_3 = 2NO + 4H_2O$$
Hydrogen + Nitric Acid = Nitric Oxid + Water

According to Veley, however, this explanation is not correct, inasmuch as pure Copper, Mercury and Bismuth do not dissolve in pure dilute Nitric Acid, but dissolve readily when nitrous acid is present, or by impurities in the metal inducing a local electric current; the first product of the Nitric Acid is Nitrous Acid, and the production of lower oxids of nitrogen he regards as due to the subsequent changes occurring between nitrous acid and the metallic nitrat or nitrit in presence of an excess of Nitric Acid, and nitrous acid being decomposed as fast as formed. [*Proceeding of the Royal Society*, 1890, 46, 216; *and others.*]

Upon the addition of the acid to the copper action should commence at once, forming a deep-green solution, and dense brown fumes of Nitrogen Peroxid liberated.

EXPERIMENT NO. 85:

Dilute the solution obtained in the preceding experiment and put in a clean test tube. Add a little Potassium Hydroxid and note results. A blue precipitat should form of Copper Hydroxid [$Cu[OH]_2$].

EXPERIMENT NO. 86:

Dilute some of the acid obtained in Experiment 84 and put in a clean test tube. Add a little Ammonium Hydroxid [NH_4OH]. Upon the addition of the Ammonium Hydroxid a dark blue solution is formed similar to the preceding, and with a blue precipitat.

Add an excess of Ammonium Hydroxid and note results. The precipitat should disolve upon the introduction of an excess of the Hydroxid.

EXPERIMENT NO. 87:

Dilute a little more of the solution obtained in Experiment No. 84 and put in another clean test tube. Add a little Ammonium Hydroxid and note results. A dark blue solution should form with a light blue precipitat. Introduce an iron nail in this solution. Upon the introduction of the nail the copper should deposit on the nail, action taking place, the nail being attacked by the solution, forming a yellow solution. Add an excess of Ammonium Hydroxid and allow to stand a few minutes. After a few minutes a brownish red precipitat of Ferric Hydrat [$Fe_2[OH]_2$] results.

EXPERIMENT NO. 88:

Copperas Test for Nitrat:—Pour into a tube 5 cc. of Sodium Nitrat [$NaNO_3$] or other nitrat solution and the same volume, both estimated, of Ferrous Sulfate [$FeSO_4$] solution freshly made. Shake the mixture well together. Then run a thistle tube to the bottom of the mixture and pour thru it about the same volume of strong Sulfuric acid, having the two tubes perfectly quiet, or use clamps [Fig. 79], till you observe a brown ring [halo] at the junction of the two liquids. Its composition is uncertain, but it comes from the action of Sulfuric acid on the nitrat to form Nitric Acid, which is perhaps reduced to Nitrous Acid [HNO_2] by Ferrous Sulfate [$FeSO_4$], which thereby becomes oxidized to [$Fe_2(SO_4)_3$]. This experiment is sometimes done by mixing the supposed Nitrat and Sulfuric acid then, when it is cool, laying the Ferrous Sulfate solution on the surface with a pipette. The brown ring is often regarded as [$FeSO_4]_x$ [$NO]_y$ [unstable].

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FOR SALE—Otis Clapp Static Machine in first-class condition. Two 19" plates on hand operated end. Ten 29" plates on power operated end. Several Leyden jars and various discharging devices to go with machine. Cabinet measures 66"x66"x30" wide. All enclosed in glass, $75, f.o.b Mattapan, Mass. Cost $450. Fritz Henrici, Mattapan, Mass.

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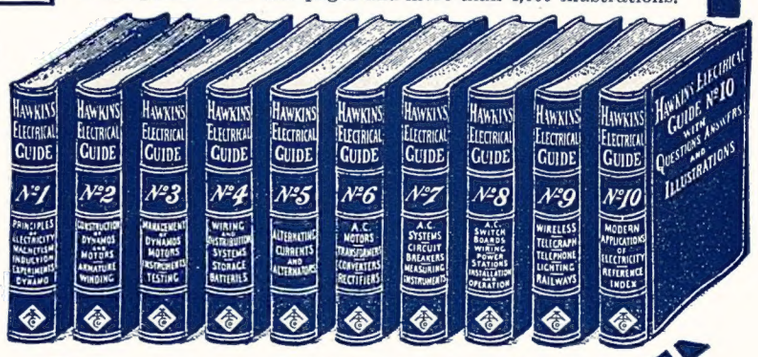

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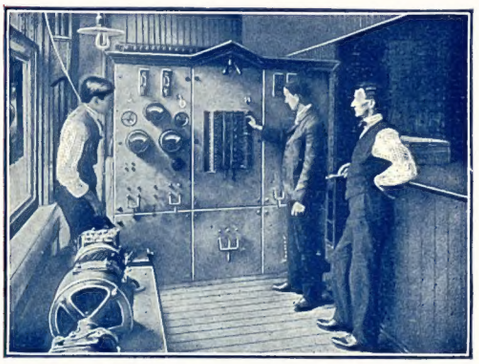

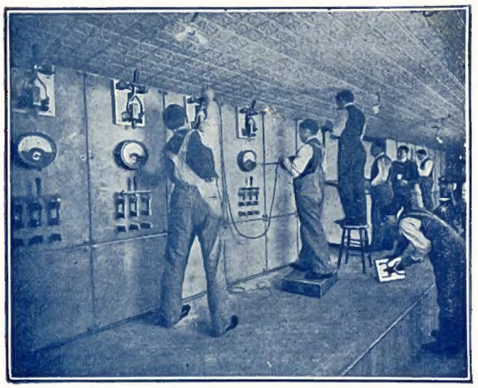

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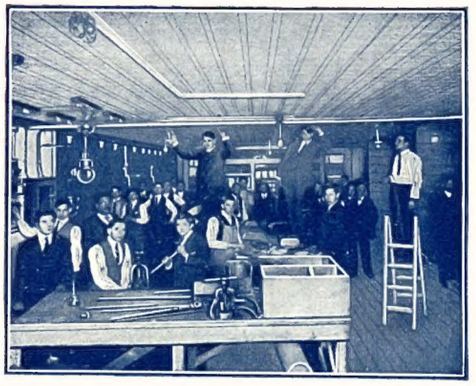

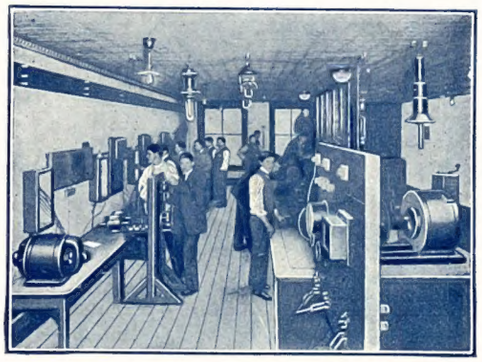

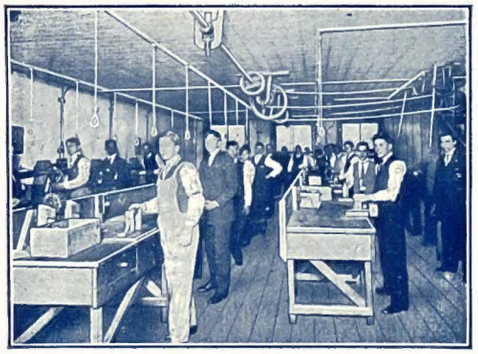

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